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FOUR-CYLINDER BALANCED COMPOUND LOCOMOTIVE, NEW YORK CENTRAL RY.

The remarkable development of the four-cylinder balanced type of compound locomotive (as distinguished from other four-cylinder locomotives) during recent years was reviewed at some length in our issue of March 31, and there are indications that the successful experience with such locomotives on foreign railways will lead to a careful trial of their merits in this country. In separate articles in the issue above referred to, we described the De Glehn engine, imported from France by the Pennsylvania R. R., and the Vauclain engines, recently put in service on the Atchison, Topeka & Santa Fe Ry. Since then still another type of engine on this system has been brought out, and has been put in service on the New York Central Ry. Like the others, it is an Atlantic (4-4-2) engine for high-speed passenger service, and a view of this engine is shown in Fig. 1. It was designed by Mr. F. J. Cole, Mechanical Engineer of the Schenectady Works of the American Locomotive Co., and was built at these works.

The special differences of the various designs of four-cylinder balanced compound engines are in the cylinder and valve arrangement, and the four types of these engines now in actual service may be divided into two groups, as follows:

(1) Engines in which the high and low-pressure cylinders drive two separate axles: (A) In the De Glehn type, the high-pressure cylinders are outside, set back of the smokebox, and drive the rear axle; the low-pressure cylinders are inside, beneath the smokebox, and drive the first axle; each cylinder has its own valve and valve gear. (B) In the new Cole type, the high-pressure cylinders are inside, forward of the smokebox, and drive the first axle; the low-pressure cylinders are outside, in the usual position, and drive the rear axle; the two piston valves for each pair of cylinders are mounted on the same stem and driven by a single valve gear of the ordinary link type. (C) In the Vauclain type of engine with the cylinders all in line at the smoke-box (as noted below), the outside cylinders may have extended piston rods to allow of attaching the connecting rods to the rear drivers. This has been done in an engine for the Chicago, Burlington & Quincy Ry.

(2) Engines in which all the cylinders drive one axle: (D) In the Von Borries type, the cylinders are all in line at the smokebox with the high-pressure cylinders inside; each cylinder has its own valve, but the valves of each pair of cylinders are operated from a single valve gear. (E) In the Vauclain type, the cylinders are arranged as in the Von Borries type, with the high-pressure cylinders inside, but there is only a single valve gear and single piston valve to each pair of cylinders.

In the new Cole engine of the New York Central Ry., the only peculiarity in external appearances is the chamber of the high-pressure valve, which is forward of the smokebox and outside cylinders. The special features of the design have been noted above, and the general arrangement is very clearly shown by the plan in Fig. 2, while the cross-sections in Fig. 3 show the cylinder and valve chamber construction. The valves are of the piston type, 14 ins. diameter at the heads and 10 ins. at the body, with a length of 27 ins. over the heads. One of the valves is shown in Fig. 4. The two valves on each side are mounted on a single stem, or rather their stems are connected end to end, so that they act as one valve, and the two steam chests are therefore necessarily in line, being between and above the cylinders. The crank axle is peculiar in having but one cheek to each crank, the middle section of the shaft being inclined or diagonal so as to connect the inner ends of the crank pins. This is shown by the plan, Fig. 2. Each outside crank is set at 180° with its corresponding inside crank, and at 90° with the opposite outside crank.

In regard to the distribution of weight, it is to be noted that each driving axle carries normally 55,000 lbs., which at first sight may seem excessive, but which was accepted by the mechanical department of the railway on account of the fact that in a balanced compound engine the weight is a steady and practically uniform load, and does not produce any "hammer blow" action upon the rails. The main frames are unusually heavy, and extend only to the second driving axle bearings; beyond these are riveted plate frames (two 1¼-in. plates on each side), with the openings for the trailing axle boxes slotted out of these frames. Plate springs are mounted over the driving and trailing axle boxes, and have their hangers connected up by equalizing levers. The trailing wheels have outside boxes.

The boiler is of the straight-top type, with inclined back head and front water leg. The dome is near the firebox, and is 30 ins. inside diameter over a hole 27 × 22 ins. in the boiler shell; the shell is reinforced at the opening by a ¾-in. liner 54 ins. diameter. The firebox is of the radial-stay type,

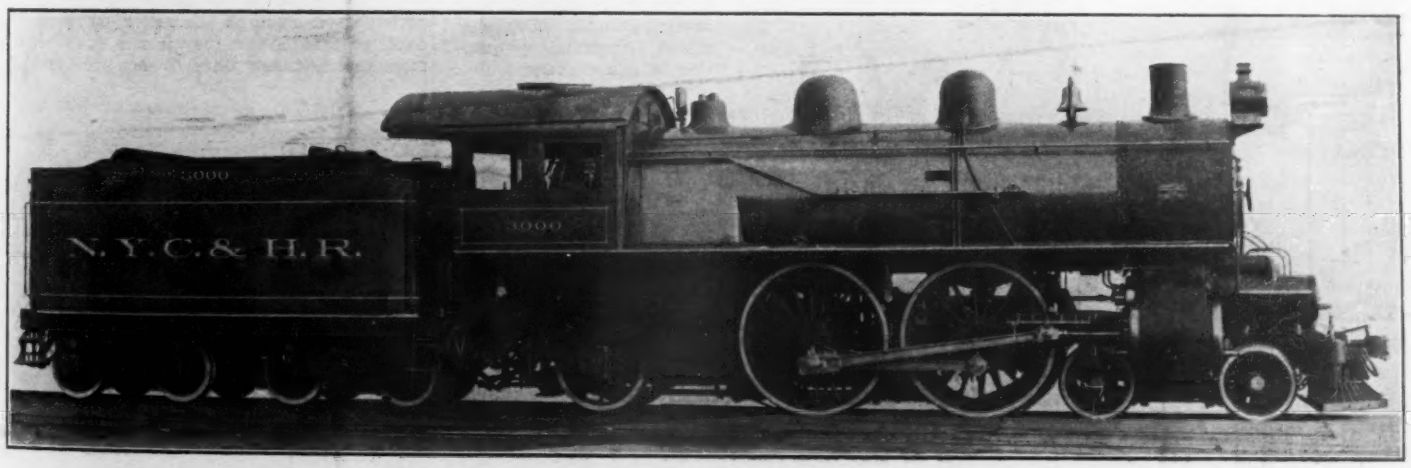


FIG. 1. FOUR-CYLINDER BALANCED COMPOUND LOCOMOTIVE; NEW YORK CENTRAL RY.
F. J. Cole, Designer; American Locomotive Co., Builders.

with a radius of 6 ft. for the crown sheet, and 15 ins. at the corners, from which the sides flare with a slight curve. The radius of the boiler shell over the crown sheet is 36 15-16 ins. The firebox has two fire holes, 15 ins. diameter, and the stay-bolts have ¼-in. holes drilled 1¼ ins. deep. In the smokebox or front end arrangement, shown in Fig. 5, the deflector plate and netting form a pocket, with the exhaust pipe entering the bottom, and two petticoat pipes directly over the nozzle, the top of which is 11 ins. below the center line of the boiler. The nozzle and smokestack are at about the middle of the smokebox, which gives the

engine the appearance of having a short extension front, although the length is 5 ft. from the tube plate to the door.

The dimensions of the Cole engine of the New York Central Ry. are given below in our standard form:

Four-Cylinder Balanced Compound Locomotive: New York Central Ry.

RUNNING GEAR:	
Driving wheels, (4) diameter	6 ft. 7 ins.
Truck wheels, (4), "	3 " 0 "
Trailing wheels (2), "	4 " 2 "
Tender wheels, (8), "	3 " 6 "
Driving wheel centers	Cast steel
Driving wheel tires secured by shrinkage and retaining rings.	
Engine truck	Swing center
Journals, driving axles	10 × 12 ins.
WHEELBASE:	
Driving	7 ft. 0 ins.
Truck	6 " 4 "
Engine, total	27 " 9 "
Tender	16 " 9½ "
Engine and tender	53 " 8 "
Truck pin to c. of first driv. axle	8 " 1 "
WEIGHT IN WORKING ORDER:	
On driving wheels	110,000 lbs.
On truck and trailing wheels	90,000 "
Engine, total	200,000 "
Tender empty	51,600 "
Tender, loaded	121,600 "
CYLINDERS:	
H. p. (2), 17½ ins. c. to c.	15½ × 26 ins.
L. p. (2), 7 ft. c. to c.	26 × 26 "
Crosshead and guides	Laird; two-bar
Connecting rod, length, c. to c.	7 ft. 9 ins.
Side rods	Solid ends
VALVE GEAR: Type	Stephenson link
Valves, piston, diameter	14 ins.
" maximum travel	6 "
" inside lap, h. p., ¼-in.; l. p.	⅜-in.
" outside lap	1 "
" lead (forward gear, at 11 ins. cut-off)	¼-in.
BOILER: Type	Straight top
Barrel, diam. inside smallest ring	6 ft. ¼ ins.
Barrel plates	13-16-in.
Smokebox tube plate	⅝-in.
Horizontal seams (butt)	Sextuple riveted
Circumferential seams	Double riveted
Height, rail to center line	9 ft. 3 1-16 ins.
Smokebox, length	5 " 0 "
Working steam pressure	220 lbs.
FIREBOX: Type	Radial stay
Length, inside	8 ft. 0⅛ ins.
Width, inside	6 " 3¼ "
Depth at front	6 " 8¼ "
Depth at back	5 " 9 "
Crown, side and back plates	⅜-in.
Tube plate	½-in.
Crown stays	Radial
Fire brick arch	On water tubes
Grate bars	Rocking
Stayboits (drilled ¼-in., 1¼ ins. deep), diam.	1 in.
Water spaces: Front, 4 to 6 ins.; back, 3½ to 4½ ins.; sides, 3½ to 5½ ins.	
TUBES: Material	Iron
Number	390
Diameter, outside	2 ins.
Length over tube plates	16 ft. 0 ins.
HEATING SURFACE AND GRATE AREA:	
Heating surface tubes (interior area)	3,248 sq. ft.
" " firebox	175 " "
" " firebrick arch water tubes	23 " "
" " total	3,446 " "
Grate area	50.3 " "
MISCELLANEOUS:	
Exhaust nozzle (single), diameter	5⅜, 5⅝, 5⅞ ins.
Exhaust nozzle, below cen. line of boiler	11 "
Smokestack (straight) diameter	18 "
Smokestack, height above rail	14 ft. 8 3-16 "
Capacity of tender tank	6,000 gallons
Capacity of coal space	10 tons

This engine will be sent to the St. Louis exhibition, at which all the four types of four-cylinder balanced compound engines above noted will be represented.

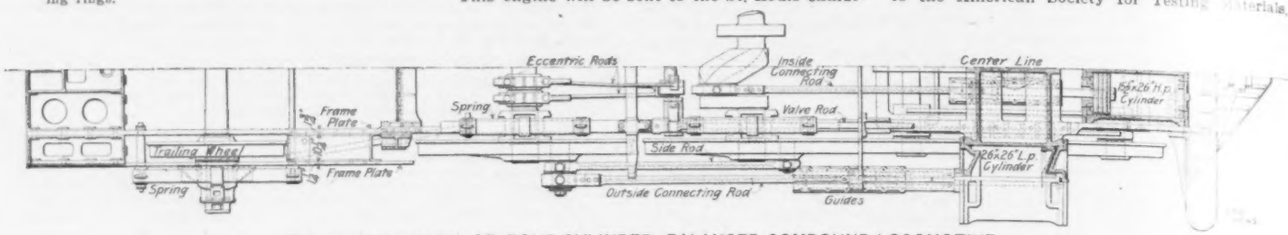


FIG. 2. HALF-PLAN OF FOUR-CYLINDER BALANCED COMPOUND LOCOMOTIVE.

ANNUAL MEETING OF THE AMERICAN SOCIETY FOR TESTING MATERIALS.

Two years ago the American branch of the International Association for Testing Materials of Construction separated from the central organization and established an independent existence. There were weighty reasons for the step. Primarily the aims and purposes of the members on this side of the water differed from those active abroad; they were more energetic and sought a broad sphere of usefulness. In second order, the unavoidable difficulties of administration in a world-society made themselves felt as a serious disadvantage to the most distant element, the American branch. The separation was a most natural occurrence and it has been fully justified by the results. The American Society for Testing Materials, as the seceding branch called itself, has since then grown very greatly, both in membership and in amount of work accomplished, and its influence and importance have advanced correspondingly. It is to-day one of the four or five engineering societies of unquestioned commanding position in this country.

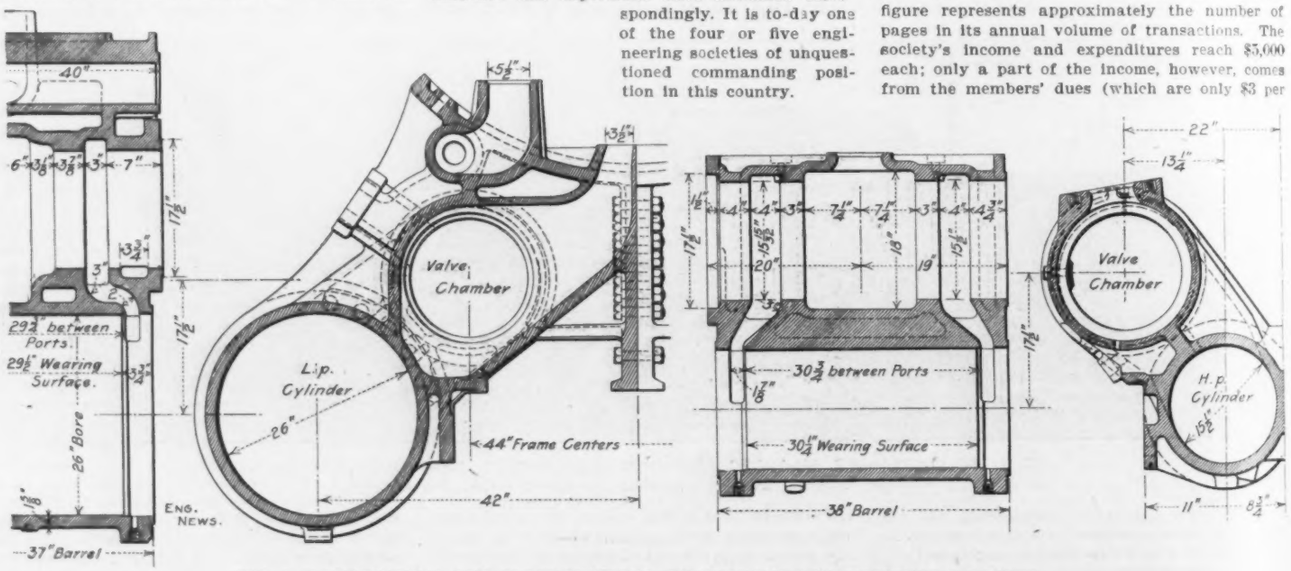


FIG. 3. LONGITUDINAL AND CROSS-SECTIONS OF HIGH AND LOW PRESSURE CYLINDER.

The separation of the American branch was not absolute, however, and this fact is responsible for a certain connection between the war in the far East and the annual meeting of the society held last week at Atlantic City, N. J. The society is affiliated with the international organization to the extent of contributing to the latter the sum of $1.50 per year from the annual dues of each member, and in return it takes part in the congresses arranged by the international association and receives the literature issued by the latter. One such congress was to have been held in the autumn of 1903 at St. Petersburg, Russia, the time being subsequently changed to 1904, and in the present year the war in which Russia became involved made it clear that a further postponement would be necessary, and the date has therefore been provisionally set at 1905. Several papers of American authors which had been prepared for presentation at this congress were in consequence of the situation submitted directly to the American Society for Testing Materials, and enriched the program of that society's meeting last week. It is proper to add, however, that the proceedings of the meeting were of such volume and quality that the addition of one or two papers, even of first quality, was of secondary moment.

The meeting comprised eight separate sessions, although it extended only over three days, beginning Thursday, June 16, and ending Saturday, June 18, 1904. Two of these eight sessions, those dealing with cast-iron and with cement, were held simultaneously, the society dividing into two sections for this purpose. Nearly 200 persons were in attendance at the meeting, and the sessions were so busy and businesslike that no time was considered available for social affairs; the only approach to such a thing was a smoker, which, however, was also a regular professional session, and at which several interesting papers were presented.

Before proceeding to review the technical work of the meeting, its principal business doings may be noted. The report of the Executive Committee, at the first session, was accompanied by a chart of growth, which illustrated the great progress of the society during the last two years. Its membership is now close to 500, and the same figure represents approximately the number of pages in its annual volume of transactions. The society's income and expenditures reach $5,000 each; only a part of the income, however, comes from the members' dues (which are only $3 per year), the remainder being raised by subscriptions and contributions. The discrepancy between expenditures and income from dues is so large that a proposition to raise the dues to $5 was unanimously agreed to, and will therefore be submitted to letter ballot of the whole society. The report contains an interesting passage on the relations of the society to the International Association, part of it being as follows:

The relations of the Society with the International Association during the past year have been limited practically to routine correspondence. . . . During the past four years the Society has remitted the sum of $1,916.50 to the International Association, for which practically no returns have been received. The American membership is now far ahead of the membership in any other country, and our remittances to the International Association are now at the rate of over $700 per annum.

The sentiment naturally resulting from this condition, that the relations between the societies require revision, is quite general among the members of the American Society for Testing Materials. Owing to the pressure of professional work, however, the matter did not come before the meeting for further discussion.

The election of officers for the coming year gave the result that the principal officers were re-elected: President, Dr. Chas. B. Dudley (Pennsylvania R. R.), Altoona, Pa.; Vice-President, Mr. R. W. Lesley (American Cement Co.), Philadelphia, Pa.; Secretary, Prof. Edgar Marburg (University of Pennsylvania), Philadelphia, Pa.; Member of Executive Committee, Mr. James Christie (American Bridge Co.), Wissahickon, Pa.

Professional Proceedings.

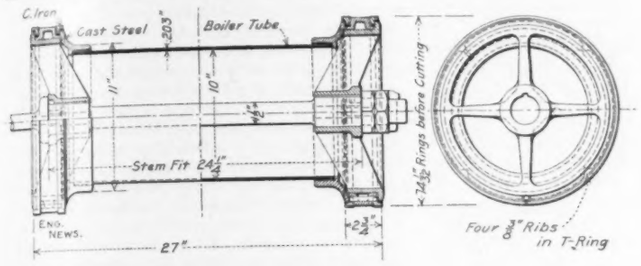
The work of the Society in its most direct form, the preparation of specifications, is done by special committees. Eleven such committees have been at work during the past year, some of them very large, for example Committee C (on Standard Specifications for Cement) consisting of 32 members. Six of these committees submitted reports at the present meeting, and a number of new specifications were received, to be submitted to letter ballot of the society. Several new committees will doubtless be established during the coming year, the meeting having recommended consideration of the matter to the Executive Committee. The subjects covered by these recommendations are: 1. Specifications for Staybolt Iron (the committee to co-operate with a committee of the American Railway Master Mechanics' Association); 2. Grading Structural Timber; 3. Fireproofing Preparations; and 4. Specifications for Standard Sewer Pipe.

The nature of the committee reports and the action of the meeting upon them are noted in proper order farther on. Interspersed with the committee reports were numerous papers on related subjects, the papers, of course, covering a much wider ground than the reports, which latter deal only with specifications. The broad range of the society's activity may be illustrated by three specimen titles: "Some Possible By-Products in the Portland Cement Industry;" "Pig Iron Feasts and Famines, their Causes and How to Regulate them;" and "Tests of Steel-Concrete," the latter paper giving the results of numerous tests rather than discussing how to conduct tests.

TESTS FOR PRESERVATIVE COATINGS FOR IRON AND STEEL.

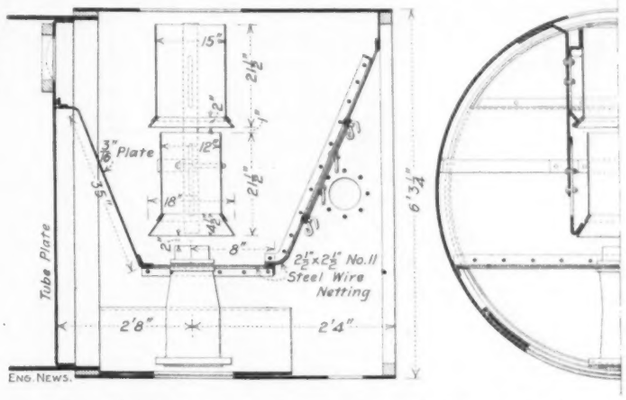
The committee on this subject (Committee E) has been at work for some years, in the attempt to establish suitable standard tests for paints on iron and steel. A lengthy report was submitted by Mr. S. S. Voorhees, Chairman, which is in effect an announcement that at present the diversity of opinions and lack of definite knowledge on the subject is such as to make it possible to submit only individual opinions of the various members of the committee. Most of these opinions appear to admit that only exposure tests, either "service" or "accelerated," can give a comparative estimate of value, and such tests are quite fully discussed. The desirable qualities of paints, and how these are approximately indicated, are also discussed. One or two new special tests are described, of which we note one, a test for porosity, suggested by Dr. C. B. Dudley (Altoona, Pa.). This test relies for its value on the principle that the complete exclusion of moisture from the surface of the metal would make corrosion impossible.

On a slip of glass put a thin coating of dextrine (20 grams dextrine, 40 c. c. water, 30 c. c. alcohol) in a spot about 1½ ins. diameter. When thoroughly dry paint the surface of the slip, including the spot of dextrine, with the paint to be tested, one or several coats, as may be desired, to correspond to the conditions of use. When the paint is dry and hard, in service condition, the slip is immersed in water. If the film is porous, water soaking through will dissolve the dextrine, giving it a whitish color and causing the overlying paint to peel off.



Sectional Side Elevation. End Elevation.

FIG. 4. PISTON VALVE.



Longitudinal Section. Half Cross Section.

FIG. 5. FRONT-END ARRANGEMENT.

Nearly all linseed-oil paints tested by Dr. Dudley showed peeling after immersion over night. Bituminous paints withstand longer, up to 48 hours, but eventually all paints yet tested will peel. Substantially the same test has been used by Prof. Ira A. Woolson (New York) and others. In order to make sure that no action between the paint and the dextrine could occur, Prof. Woolson used a postage stamp (the adhesive coating of stamps is dextrine) stuck on a slip of glass, with the paint applied over it. Here the paper protects the dextrine from the oil of the paint, but admits water. Mr. S. S. Voorhees (Washington, D. C.) reported testing a number of paints by Dr. Dudley's method, with somewhat different results. He allowed his samples of linseed-oil paints to dry 40 days before immersion, and then found that peeling did not result after 100 hours immersion. Three coats of paint were used, against two coats in Dr. Dudley's work. A modification of this method of test has been suggested: using a gelatine capsule whose exterior is coated with the paint to be tested; after drying the capsule is floated on water, and the penetration of water is revealed by the sinking of the capsule.

The general subject of Preservative Coatings for Iron and Steel was treated also by Mr. Robert Job (Reading, Pa.) in a paper entitled "Results of an Investigation Concerning Causes of Durability of Paints for Structural Work. The investigation was due to the observation that two different paints used for some ten years on the bridges of the Philadelphia & Reading Ry. showed greatly different durabilities, although their compositions were almost identical: a pigment of about 22% oxide of iron, mainly sesquioxide, and 78% clay, ground in raw linseed oil and thinned with the same. One of the paints lasted about twice as long in service as the other, and on examination it was found to have a much more finely-divided pigment than the other. A test for fineness of pigment was therefore evolved. It depends upon the separation or non-separation of the pigment from the oil when a drop is placed on a vertical or inclined glass plate and left to stand a certain length of time. A closely similar test was specified by the Pennsylvania R. R. in 1893 for freight-car paints. Both Mr. Job and Dr. Dudley specify that the oil of the paint shall be wholly dissolved away from the pigment, the latter washed and dried and then mixed with pure raw linseed oil free from moisture, in certain proportions. The purpose of this is to make tests on different oils comparable by eliminating the possible variation due to the physical nature of the oil, since in some cases a paint can be made to pass the test by adding a drop of water, while not passing in the condition it is received in. Mr. Job also found that certain pigments, particularly when ground in oil, cannot practically be ground as fine as others, or as fine as is desired. Pure sesquioxide of iron can be ground very fine, and it is desirable that the pigment (of an iron paint) should have as high a percentage of sesquioxide as possible. The remainder of the pigment, about 75%, should be fine paper clay, which was found to be the best from the standpoint of fine grinding. The pigment should first be ground dry, as grinding in oil prevents reaching the greatest fineness, then ground in raw oil and thinned with oil and a little japan.

The discussion of the subject dealt largely with proper method of applying paint, and while interesting most of it will be omitted here as not relating to the subject of paint tests. It may be remarked, however, that Prof. A. H. Sabin (New York) strongly emphasized the importance of properly preparing the surface to be painted, and applying the paint in thorough manner; the life of the coating may thereby be increased by two or three times, as compared with the life ordinarily obtained, in bridge work for example. Dr. Dudley seconded these opinions, although he does not believe that the preparation of the iron surface need be as thorough as recommended by Prof. Sabin. He questions whether a paint on a perfectly clean iron surface would last any longer than paint on a surface from which merely all loose rust and dirt have been removed. The allowable time of drying also gave rise to difference of opinion. In view of the importance of hurrying painted work into service, Dr. Dudley prefers rapidly-drying paints, while Prof. Sabin wants at least two weeks for the paint to dry (in normal temperature) before being put in service. But by heating the work to a moderate temperature a 14-day paint may be dried in half a day; in this connection Dr. Dudley remarked that this question had been considered by the Pennsylvania R. R. and that drying ovens may be established in the future for the steel car work of that company. Another interesting statement was the description of a method recently used in painting the Jersey City trainshed of the Pennsylvania R. R., whereby an almost perfect protection seems to be secured, under very trying conditions. The ironwork was first cleaned with wire brushes, the coating of rust being in some cases up to 3-16-in. thick and representing thicknesses of metal from 1-50 to 1-16-in. Then a coat of paint was applied, and before this dried it was covered with a layer of thin paraffine paper, lapping all edges. The final coat of paint was put on over this paper. During two years this coating has apparently given perfect protection. The method is due to Mr. L. H. Barker, Superintendent of the station. The object of the paraffine paper, of course, is to give a perfect seal against moisture.

The value of the test for fineness given by Mr. Job was questioned by Mr. G. W. Thompson (New York) on the ground that a coarser pigment may give equally as good results as a finer pigment with a different quantity of oil, whereas Mr. Job uses a constant ratio of oil to pigment in his test

(11 grams of oil to 3 grams of pigment). The more finely-ground pigment will not cover so well as the coarser, and it is more difficult to paint with. He would amend Mr. Job's principle, that the finer pigment is the better, by adding: consistent with proper application and proper covering power.

The porosity of paint films appears to be due to minute bubbles in the coat. Dr. Dudley found these bubbles in investigating some black paints in films thin enough to be transparent on glass. Here the bubbles were painly visible. The protecting film is, of course, very much thinner where a bubble occurs, and a leak would form here first, admitting moisture to the metal underneath and causing progressive rusting of the iron and destruction of the paint. The impossibility of getting rid of these bubbles or of knowing in what degree they are present forms a weakness of all paint tests made on dried films. It was suggested by Mr. Forrest (New York) that this matter of air-bubbles may point an advantage for paints which dry by evaporation; the second coat applied should dissolve part of the first coat and tend to fill up and obliterate the air-bubbles. In contradistinction to the idea that paint coatings fail by admitting moisture to the iron and setting up corrosion which causes the paint to peel, Mr. M. McNaughton (Jersey City, N. J.) gave it as his experience that paints fail by destruction of the paint coating itself rather than by corrosion of the metal below. Mr. T. D. Lynch (Pittsburg, Pa.) raised the question of the effect of acid in the oil upon the life of the paint, referring to the fact that this has been a great source of trouble in electric insulation, both fatty acids and mineral acids being usually present in the oil. Mechanical injury as a cause of short life of paint was the subject of some discussion. In most cases there is no way to minimize this, especially in steel cars. The advisability of testing paint films for strength and resistance to abrasion received some general consideration in the report of the committee (above mentioned). Mr. James Christie (Wissahickon, Pa.) mentioned that the American Bridge Co, uses an abrasion test, a standard sand falling a standard height on a painted plate set on a slope; the measure of resistance is either the time required to cut through the paint or the amount removed in a given time, as determined by weighing.

The preceding brief summary of the discussion on paints illustrates the great lack of exact information on this subject, a lack also evident from the committee's report. The committee was continued in charge of the subject, and it is hoped that the publication of its report will bring out information and suggestions from many sources. Mr. J. F. Walker, Bridgeport, Pa., is secretary of the committee.

The presidential address, read by Dr. C. B. Dudley at the second session of the meeting, was most interesting. His subject, "The Influence of Specifications on Commercial Products," was treated by the means of several striking illustrations taken from the history of the Pennsylvania R. R. testing laboratory at Altoona, which Dr. Dudley has conducted for many years with valuable results. The address is reprinted on another page of this issue. One of the illustrations used by Dr. Dudley, the specification for steel for car-springs, was further illuminated by Mr. William Metcalf (Pittsburg, Pa.), who is one of the pioneers of the American steel industry. At the time this specification, calling for steel of 0.90 to 1.10% carbon was issued (about 15 years ago), Mr. Metcalf was making springs, and he was one of the strongest objectors to the specification. However, he ordered a large shipment of steel from the largest open-hearth plant in the country. This was found to be so variable in carbon (0.70 to 1.20%) that it could not be used for the springs in question. A second and third order had a similar result, and then the steelmaker gave up the problem, confessing himself unable to produce steel within the required limits in his large furnaces (20-ton). Mr. Metcalf then built a 5-ton furnace and produced a steel of the proper carbon; to-day, however, the required limits can be readily maintained in 50-ton furnaces. The demands of the consumer as expressed in specifications have thus directly brought about a long advance in steelmaking.

HIGH-SPEED STEEL.

In a paper on "Alloy Steels," Mr. Wm. Metcalf (Pittsburg, Pa.) gave some description of the present-day conditions in the fields of making and using "high-speed" tool steel. He also noted the characteristic compositions and qualities of the other leading alloy steels: nickel steel, manganese steel, and air-hardening steel. The Taylor-White high-speed steel was first produced from the latter variety of steel, by heating to near fusion and quenching. But, Mr. Metcalf, proceeds, the process seems to have been uncertain, that is to say, when a tool was handled just right it produced results that were wonderful, and when the manipulations were not exactly right the results were nil.

The potentialities were so great that nearly all of the leading steel makers in the world attacked the problem, with the result that the present high-speed steels are in no sense of the word air-hardening. Manganese has been reduced from 3-4% to 0.30%-traces; Tungsten has been increased to 10 to 20% instead of the usual 4 to 6% and the carbon is generally less than 1.0%.

There are about fifty different brands on the market, and of course each one is the best; perhaps the analysis of two of the leading brands will be interesting.

Tungsten	9.90	18.48
Chromium	2.83	2.90
Carbon	.60	.79
Phosphorus	.010	not determined
Sulphur	.010	" "
Silicon	trace	" "
Manganese	"	.33

Another contains:

Molybdenum	9.65
Chromium	0.00
Carbon	.66
Phosphorus	.016
Silicon	.046
Manganese	.22

In one sense, it is chaos, all traditions as to heating are completely reversed and no one really knows what is the best, one brand is famous for its excellence in one kind of work, another in another kind, no one yet seeming to cover all of the ground.

There are many records published of the work done by this steel, giving speed per minute, feed, depth of cut, etc., so that it is not necessary to repeat them here; a few illustrations of what can be done may be interesting.

In one case a couple of steel cast bed plates about 4 ft. wide and 9 ft. long were to be planed; there was nominally ½-in. to come off, but the unevenness of the casting made the cut about one inch in places. The surface was hard and gritty from the sand of the mold. Several tools were tried, each one going about half an inch and then having to be reground; next one tool cut about two inches without grinding; finally, a tool was tried that had turned up a large, rusty cast-iron pulley, without grinding, and it cut clear across the bed plates and was still in good condition for further work. It is clear that the cost per pound of that tool cuts no figure.

Another party had a great many castings to thread; with dies made of the very best carbon steel he could at moderate speed thread from 2,000 to 3,000 pieces without grinding; with dies made of high-speed steel and with his machine running as fast as he can drive it, he threads from 20,000 to 30,000 pieces without grinding.

Another party turns many pieces of hard brasses and found it difficult to get a tool that would cut them at all until he tried the right high-speed steel and made a tool that would cut all day without grinding, running his lathes at the highest speed he could get. The same party bores many cast-iron cylinders, and with tools made of steel that would not cut his brass he bores eight to ten cylinders without regrinding, and at a speed so great that the cylinders come out too hot to be handled with the naked hand. He tried in his cylinders the steel that cut his brass so well and it would bore only two to four cylinders without grinding.

Another party drills 2⅝-in. holes 7 ins. deep in soft steel forgings, drilling a hole in about three minutes; the same steel will not make a good threading die for the same forgings, and for this he uses another brand; neither of these steels will make a good lathe tool for turning these forgings, and for this work he uses a third brand. All of these brands upon analysis would come within the limits of the analyses given above.

From all of this two things are clear: one is that there has been a marvelous, a revolutionary, advance in the machining of metals; the other is that steel makers have met the demand remarkably. It is also clear that we do not know yet where we are, and there is much to be learned by everybody. The best methods of hardening may not have been found; it seems that for high-speed work it is necessary to fairly melt the point of a tool and quench it in a strong air blast and then grind to shape. This would not do for threading dies, milling cutters, etc., for the heat would destroy the tools. Such tools are finished from annealed bars; this high-speed steel can be annealed as nicely as carbon steel, differing in this respect from air-hardening steel.

The steel maker has the most to learn; he must find out why there is such a great difference in the work the steel will do when there is so little difference in composition. He must find the composition, or mixture, that will come nearest to meeting all of the requirements; he has at command now ferro-manganese, ferro-silicon, ferro-chromium, ferro-tungsten, ferro-molybdenum, ferro-vanadium and ferro-titanium; these alloys are all expensive except the first two, costing from 60 cts. to $12 a pound; therefore the present prices of high-speed steel, which to some people seem to be of the fancy order, are really not excessive.

As far as we know at present the steel users have not succeeded in making tools that are satisfactory for finishing, and for this purpose they resort to tools of carbon steel after having done the rougher, heavier work with high-speed steel. This difficulty may be overcome by proper methods of hardening and tempering, or the steel makers may find a composition that will make a tool that is as good for finishing as for roughing.

In the discussion of this paper Dr. C. B. Dudley (Altoona, Pa.) cited the composition of a bar forged from the sinking head produced in the attempt to weld a broken locomotive frame with thermite. The metal was a manganese-silicon steel, with Mn 2.32%, Si 1.23%, while carbon, sulphur and phosphorous were very low. The bar tested in tension gave 91,600 lbs. per sq. in., and 21.5% elongation in 8 ins. The suggestion that such a steel might replace carbon steel, because the oxides of Mn and Si are solid while those of carbon are gaseous, met with the reply from Mr. H. H. Campbell (Steelton, Pa.) that what got cast from such material would be piped as badly as to be worthless. The same objection applies to perfectly "dead" steels made by going high in aluminium or silicon. It was further noted by Dr. Dudley that the attempts to weld wrought-iron locomotive frames with thermite at Altoona had been practical failures.

The distinction between air-hardening and high-speed steels caused some discussion. Mr. Albert Sauveur (Boston, Mass.) held that they were substantially identical, differing only in heat-treatment. But both Mr. Campbell and Mr. Metcalf dissented from this, on the ground that while originally high-speed steel was made from air-hardening steel, to-day the former is a wholly different material; its manganese has been lowered to less than 1%, where it no longer is a characteristic constituent, and tungsten or molybdenum have been introduced in amounts up to 10 or 20%. Air-hardening steel owes its properties to the high manganese it contains, while high-speed steel depends on its tungsten or molybdenum, and is not capable of air-hardening.

An illustrated address by Mr. R. W. Lesley (Philadelphia, Pa.) on "Some Statistics of the Cement Industry in America" gave an interesting graphical exhibit of the growth of Portland cement manufacture, from 85,000 bbls. per annum in 1882 to 17,000,000 bbls. in 1902, a multiplication of 200 times.

As was the case last year, the subjects of Cast Iron and Cement were handled by two simultaneous sessions. The section on Cast Iron was under the presidency of Dr. Dudley, while Mr. R. W. Lesley took the chair in the other. Both sections had final drafts of specifications on the respective subjects submitted to them by the standing committees of the society.

SPECIFICATIONS FOR CAST IRON AND FINISHED CASTINGS.

The report of the Committee on Cast Iron included six separate specifications, as follows: 1. Foundry Pig Iron, 2. Cast-Iron Pipe and Special Castings, 3. Locomotive Cylinders, 4. Cast-Iron Car Wheels, 5. Malleable Castings, and 6. Gray-Iron Castings. These are all in nearly their final form, and action was taken on them as noted below. In addition a paper by Mr. W. J. Keep (Detroit, Mich.), entitled "Cast Iron; Strength, Composition, Specifications," was presented in discussion of the Gray-Iron Specifications. This paper was also presented before the meeting of the American Society of Mechanical Engineers at Chicago two weeks ago (see Eng. News, June 9, 1904). It attacks the standard or "Arbitration" test bar suggested by the committee (a round bar 1¼ ins. in diameter cast on end) as being inferior to the square bar and as giving results not comparable with those of tests made in the past on other sizes of test bar. A reply was submitted by Mr. Thos. D. West (Sharpsville, Pa.), of the committee, who argued in defense of the Arbitration bar. Quoting tests made by him in 1894 on 1¼-in. round bars and 1-in. square bars, he showed that the round bar was the stronger in every grade of cast-iron. Mr. Keep's objections to the difficulty of molding the iron bar vertically and to the risk of gas and dirt in the bar on account of the small exposed surface, were also opposed by Mr. West. The discussion of the whole group of specifications was rather extensive, a number of minor points of objection being raised. These ultimately led to a vote that the specifications (except the gray-iron specification) be referred back to the committee for modification of these minor points, and be then submitted to the Executive Committee, who may send them out for letter-ballot without further consideration by a regular meeting of the society. The gray-iron specification was referred back to the committee for further consideration, the committee to report at the next annual meeting of the society.

SPECIFICATIONS FOR NATURAL AND PORTLAND CEMENTS.

The report of the Committee on Cement included a complete specification to govern the acceptance of cements, and this specification was ordered by the meeting to be sent out for letter-ballot of the membership-at-large. The specification and the accompanying explanatory remarks will be reprinted in another issue of Engineering News.

The motion to submit the specifications to letter ballot was not carried without opposition, however. Mr. C. F. McKenna (New York) led in objecting to their acceptance without revision, on the grounds that the definitions given to natural and Portland cements are unsatisfactory, and that the required limits of strength are improperly specified. Mr. A. L. Johnson (St. Louis, Mo.) also declared himself dissatisfied with the strengths specified, holding that a good Portland cement should show at least 200 lbs. on a 7-day test of 1 to 3 mortar (instead of "150 to 200 lbs." as allowed by the specifications. But this met the reply that while some laboratories may show regular results as high as this, many others will not, and the specification must be of general applicability. Moreover it was argued that many engineers are inclined to look suspiciously on very high-testing cements. The specification as submitted was defended, mainly by Mr. R. L. Humphrey (Philadelphia, Pa.), Mr. G. S. Webster (Philadelphia, Pa.) and Prof. W. K. Hatt (Lafayette, Ind.) as being fair, workable and safe. The need for having a standard specification without further delay was emphasized; modifications can be made later, without serious difficulty, as may be found desirable after working experience with the specification. These reasons ultimately prevailed to the extent that a motion of Mr. McKenna to recommit the specification to the committee was defeated, and a motion to issue the specification for letter-ballot was carried.

Mr. McKenna's ideas on cement testing were more fully detailed in a paper on "Practical Cement Inspection," which he presented immediately following the disposition of the committee report. One of his principal recommendations was that short-time tests should be 3-day and 7-day, omitting the 24-hour test because of its variable results. He believes that briquette molding should be done more carefully than is usually the case, and by specially-trained men, in order that concordant and more reliable results may be obtained. The least possible number of samples should be used, and these should be suggested to numerous but simple tests. Other specific recommendations were made in the paper, and an annual specification was cited and discussed in detail.

Three papers dealing either with cement-making or with cement-testing were next presented. Mr. Clifford Richardson reported an interesting matter in a paper so short that we reprint it in entirety below:

SOME POSSIBLE BY-PRODUCTS IN THE PORTLAND CEMENT INDUSTRY.—Clifford Richardson, Long Island City, N. Y.

In the course of the investigations conducted by Dr. W. Hillebrand at the request of the Committee on Uniform Methods of Analysis of Materials for the Portland Cement Industry he found that when a raw mixture which contained 0.69% of potash and 0.22% of soda was ignited in a platinum crucible for one hour over an ordinary blast lamp the resulting cement contained but 0.07% of potash and 0.09% of soda. The alkalies had been nearly completely volatilized and the potash more completely so than the soda.

It at once became of interest to determine whether the same thing took place in the industrial production of Portland cement clinker. It was found that from a raw mixture, made from marl and clay which contained the percentages of alkalies mentioned above and which should, in consequence, contain 1.26% of potash when burned (if none of it was volatilized) since the loss on burning was 37.50%, 0.65% potash was carried off in the flue gases at the temperature of the rotary kiln. An investigation of the flue dust proved that the alkalies were carried further than the point where this material is deposited, and it is apparent that by conducting the gases through a long, horizontal chamber where the temperature could be reduced to a point low enough to permit of the deposit of the potash this could all be collected, perhaps aided by a spray of water or steam.

The importance of this discovery is apparent if a calculation is made of the actual weight of potash which is produced and lost in this way in a cement plant turning out 4,000 bbls. a day, or 700 tons of material. Six-tenths of one per cent. of this would mean 4.2 tons of potash which now goes to waste, but which could be readily collected and have a value of at least $12 per ton (that of kainite with 12% of potash) and with a probable value of $45 per ton, that of the commercial muriate used for fertilizing purposes. In the latter form our 4.2 tons of potash would be the equivalent of 6.6 tons of muriate, so that, allowing the excessive sum of $50 per day for the expense of the process and interest charges, the profit from a single plant of the size mentioned would be between $100 and $200 per day. It would seem that the development of the process would be of commercial interest. In conclusion it may be said that Dr. Hillebrand has an application pending for a patent covering it.

In connection with this paper, Mr. R. W. Lesley (Philadelphia, Pa.) made the interesting announcement that a cement plant is now being built in West Virginia directly alongside a fertilizer works, and that it may be found possible there to recover the alkalies and dispose of them to the fertilizer works.

A paper by Mr. F. H. Lewis (Craigsville, Va.), entitled "The Boiling Test for Portland Cement," suggested that a cement of rather novel composition might be made for the special purpose of passing the much-discussed boiling test. The cement would be practically a lime-silica-iron compound, with aluminium reduced to 2% or even lower. The cement would be nearer to hydraulic lime than to ordinary Portland cement. It would be very slow in setting, rather lower in strength than Portland, and of absolute constancy of volume. Mr. Clifford Richardson (Long Island City, N. Y.) reported having made some cement similar to that described, some years ago. It proved perfectly volume-constant, but very slow in setting, and tested only about 400 lbs. after 28 days. Such cement would give trouble, he thought, in the ordinary kiln in burning a uniform product. The further discussion turned more generally on questions of the composition of cement, but is of less interest here.

Promising results from a new method of molding briquettes for cement tests were reported by Mr. W. A. Aiken (Pittsburg, Pa.), as the result of experiments made in connection with the material tests for the New York Rapid Transit Ry. The method aims to secure more uniform results, and consists in molding the briquettes dry, of neat cement, and hardening by immersion in water:

> We have for two years been regularly making up every tenth lot of cement submitted for use on our work, under what I call the dry process of briquette-making, in addition to our usual method as practiced in laboratories generally. After much experimenting and numberless trials I finally settled upon the method which we have rigidly adhered to ever since. Our gang molds are filled with dry cement in three layers, the two lower ones being tamped by three blows of a wooden mallet and a tamping iron exactly fitting the molds, the top layer being simply put into place, pressed in and smoothed off with a small trowel after the molds have been filled. . . . After the briquettes are finished, as far as filling the molds is concerned, the whole is put into storage tanks and there left to take up as much water as required. At the expiration of 24 hours all the briquettes are ready to be taken from the molds, when those for the first period are immediately broken and the others stored in tanks.

Mr. Aiken claims for this method that the test results are much more uniform than with wet-molded briquettes, there being less of the "personal equation" of the briquette-molder in the result. Further, the "dry" briquettes show not only a higher strength, but also a higher gain in strength between 7 and 28 days, for the same cement. It is to be understood that this method of testing has not been used to govern acceptance of cement for the Rapid Transit work, but the dry tests have been regularly made for the purpose of comparison and study. Mr. R. L. Humphrey (Philadelphia, Pa.) could not record the same favorable results for the "dry" method, which he tried some years ago; he found it gave no more uniform results than the ordinary method.

TESTS OF CONCRETE-STEEL BEAMS.

Three papers recording results of tests made on concrete-steel beams formed part of the program of the Cement section. These papers were by Prof. A. N. Talbot (Urbana, Ill.), Prof. F. E. Turneaure (Madison, Wis.), and Prof. Edgar Marburg (Philadelphia, Pa.). We hope to present these papers in a future issue. Their results, briefly summarized, are as follows:

Prof. Talbot made a large series of experiments on beams of plain concrete and beams reinforced with metal of various shapes (Ransome, Thacher, Johnson, etc.) in various percentages. The beams were all 12 ins. wide, 13½ ins. deep, and 14 ft. between supports. They were loaded symmetrically, so as to produce a uniform pure bending moment in the middle section. The deformations of the material were measured at a point near the top of the beam and a point near the bottom (just opposite the center of the steel), by means of extensometers spanning about 5 ft. The curves of compressive stress in concrete, tensile stress in steel, and deflection of beam, could then be plotted for varying loading. These curves show four stages: (1) uniform deformation of slow rate; (2) a short, more or less irregular period of more rapid deformation, somewhat similar to the yield-point in wrought iron; (3) a period of regular deformation more rapid than (1), and (4) a period of rapid increase of deformation to failure, this period affecting the steel-curve or the concrete-curve, depending upon whether the steel is under or over proportioned. Prof. Talbot calls (2) the period of readjustment, when the concrete on the tension side is shifting its stress to the steel. After this period the deformations are again almost proportional. From the deformations of concrete and steel the position of the neutral axis was computed and plotted. After the readjustment period there is very little change in the position of the neutral axis. A calculation of the resisting moment at rupture showed that, for an assumed distance of 4-11 from the neutral axis to the centroid of compression forces, the moment calculated from the steel alone (no tension in the concrete) agreed closely with the external bending moment. A separate test, using several extensometers at varying levels, showed that "plane cross-sections remain plane" within the limits of observation.

The paper of Prof. Turneaure gave some more direct evidence of the disappearance of tension from the concrete at an early stage in the loading. His test-beams were 6 × 6 ins. in section, and were tested with the tension side on top. The beams were tested while still moist from their immersion in water, and to this moisture is due the discovery of numerous minute cracks in the concrete on the tension side when the elongation reached a certain amount. These cracks first appeared at a certain amount of deflection, whether steel was present in the beams or not. They were at first very short, no single crack extending all the way across the beam, but were quite regularly distributed over the tension surface. The presence of water made them show as fine dark lines, while if dry they would have been hardly perceptible even under a microscope. With the 1:2:4 concrete used in the experiments, these cracks were first observed at an elongation of .0001 to .00015 (corresponding to 3,000-4,500 lbs. per sq. in. stress in the steel); they reached a size and extent perceptible to the naked eye (if the beam were dry) only at an elongation of .0004 to .0005 (12,000 to 15,000 lbs. per sq. in. in the steel), and then generally extended clear across the tension surface and some distance along the side of the beam. The extensometer tests made coincident with these observations gave results corresponding closely to those obtained by Prof. Talbot. Taken together with the observations on the cracks they show conclusively that at an early stage in the loading the concrete loses all or most of its tensile resistance, so that the steel carries the tension at all higher loadings.

The experiments of Prof. Marburg made on 8 × 8-in. beams of 1:2:4 concrete with 0.8 to 1.2% reinforcement, gave results agreeing generally with those of Prof. Talbot. Owing to the late hour to which this session had extended, these interesting results were not discussed. The meeting closed with a short paper by Mr. E. W. Lazell on "The Mechanical Defects of Sieves used in Determining the Fineness of Cement." The author had examined a large number of sieves, from 50 to 200-mesh, by means of photographic enlargements. He found in many cases serious defects, in varying gage of wire, incorrect number of meshes, and also irregularity of mesh. He recommended careful examination of all sieves intended for careful work on cement.

SPECIFICATIONS FOR IRON AND STEEL.

A short report was submitted by the committee in charge of Standard Specifications for Iron and Steel. The present standard specifications of the society disagree in various minor points with the corresponding specifications of the American Society of Mechanical Engineers, the American Railway Master Mechanics' Association, and the American Railway Engineering & Maintenance of Way Association. The committee was not wholly agreed that a revision of the society's specifications would be desirable, and therefore

submitted the question to the meeting. Differences of opinion at once became evident, and it was only after some discussion and much parliamentary tangle that a motion was passed to instruct the committee to consider the entire group of iron and steel specifications with the aim of bringing about joint-standard specifications of the four societies. Before this result was reached, Mr. J. P. Snow reported briefly on the final specifications for Iron and Steel Structures, adopted by the American Railway Engineering & Maintenance of Way Association in March, 1904; Mr. H. V. Wille presented a comparison of the high-steel specifications of the Master Mechanics' and the Mechanical Engineers' societies, with those of the American Society for Testing Materials; and Mr. W. R. Webster reported briefly on the Steel Rail specification adopted by the Maintenance of Way Association last March. These separate reports, which were merely descriptive and in no sense criticisms, made it strongly apparent that the society's specifications required reconsideration if any uniformity was to be obtained or if its specifications were to establish themselves as standards. The action finally taken, already noted above, is the more appropriate in view of the fact that the other societies referred to already have committees working in conjunction with the committee of this society for the purpose of agreeing on a uniform set of specifications, if possible, and the final reports of these committees have not yet been received. The committee will now proceed to a full consideration of the specifications, in consultation with the committees of the other societies, and will print and distribute the result of its work before the next annual meeting.

SPECIFICATIONS FOR AIR BRAKE HOSE.

A paper under the above title read by Mr. M. H. Wickhorst (Aurora, Ill.) recorded some tests made for the Chicago, Burlington & Quincy Ry. to determine the necessary qualities of air brake hose. It was suspected that the Master Car Builders' specification was too severe, requiring a higher-priced hose than the service calls for. This was in a measure verified by the tests, and a new specification was adopted by that railway, over two years ago. This test requires no unwinding test of the hose, to determine the adhesion between the layers, because it was found that nearly all qualities of hose lost the greater part of this adhesion shortly after being put into service. A lesser stretch is also required in the test of the inner tube, 300% instead of 400%. The author gave a record form used for noting the manner of failure of air hose, and presented a table showing the results of this record for two years past. According to this table 92% of air-hose failures are due to external mechanical injuries, while only 8% are traceable to the quality of the hose. The analysis of the causes of failure makes it clear that most of the failures are directly due to rough handling on the part of the trainmen.

In discussion Dr. C. B. Dudley gave as a reason for requiring high "friction," or unwinding resistance, the fact that air leaking through a puncture in the inner hose may follow the layers and cause a leak of the hose. Weak spots between layers have been found by him which were undoubtedly due to drops of moisture, as perspiration, between the plies while winding the hose. The absence of a test for durability of the rubber was noted, but this results from the general lack of knowledge about rubber. Mr. James Christie (Wissahickon, Pa.) remarked that hose used for pneumatic tools in workshops showed great differences in its resistance to the dissolving action of oil. It is not certain that pure Para rubber resists oil as well as mixed rubber, though the latter is inferior in stretch, so that the elongation test cannot be said to ensure the best quality of rubber.

At the "smoker" held on Friday evening, June 17, Prof. G. Lanza (Boston, Mass.) gave a valuable historical review of the development of material-testing in the United States, under the title "A Brief Review of the Status of Testing in the United States." It would be impracticable to offer any abstract of this address here. Some interesting remarks were contributed, in discussion of the subject, by Mr. Wm. Metcalf (Pittsburg, Pa.), who gave a few reminiscences of the iron business during the period around the Civil War.

Following this, Mr. Wm. Campbell (New York) gave an illustrated lecture on "The Structure of Alloys," in which he showed, by means of microphotographs reproduced in lantern-slides, how the individual elements and the eutectic combinations in alloys arranged themselves in alloys of various composition-per cents. Such alloys as copper-silver, babbitt, bronze, etc., were used for these illustrations.

Mr. F. A. Kummer (New York) read a short paper entitled "The Effects of Preservative Treatment on the Strength of Timber." This paper outlined a series of tests which the author is preparing to carry out, to determine how the various preparatory and final treatments used in timber-impregnation affect the strength and elasticity of the material. In connection with this paper Mr. H. von Schrenck, of the government's Bureau of Forestry, described the nature of the extensive timber tests which will be carried on at the St. Louis Fair (at the outdoor mining exhibit) during the present summer. The effect of impregnation and preparatory treatment will form an important element in these tests, which are in direct charge of Prof. W. K. Hatt (Lafayette, Ind.). In appreciation of the importance of this work, Prof. Lanza submitted a resolution, addressed to the Secretary of Agriculture and to the Forester of the Bureau of Forestry, asking that the fullest possible appropriations be made for the St. Louis timber tests.

Some further history was given in a paper on "The Early History of 60,000-lb. Structural Steel" by Mr. S. T. Wagner (Philadelphia, Pa.), of which we expect to give a brief account later. This material, now so widely standard, was really created about two decades ago, when the government began the construction of several new war-vessels. The specification of 60,000 lbs. tensile strength and 25% elongation in 8 ins. was after much discussion adopted by the committee of the House of Representatives for the material for these vessels. As Mr. Wm. Kent (Syracuse, N. Y.) explained in discussion of the paper, this specification might be called a fortunate error. Steel of 60,000 lbs. strength had been made before, and 25% in 2 ins. was often specified, but 25% in 8 ins. combined with 60,000 lbs. strength was a new thing and can hardly have found its way into the Congress bill except by mistake. Mr. Kent also told of how the contract for this steel was refused by Shomberger, the Pittsburg steelmaker, so that the contractor for the vessels, John Roach, of Chester, Pa., had to make the steel himself, and succeeded.

The widest departure from the subject of testing materials was marked by the next paper read: "Pig-Iron Feasts and Famines, their Causes and How to Regulate Them," by Mr. G. H. Hull. The paper referred to the periodic great variations in the iron market in this country, with eight great iron famines in 80 years. He attributed these wholly to the lack of regulating influence in our present system of buying iron, and suggested the adoption of something similar to the Scotch "warrant" system of buying iron, as a remedy. This, he believes, would greatly equalize demand and supply. As part of our present system of buying, he especially condemned the "strike or accident" clause which forms part of all iron contracts in this country. Its effect is to make the seller careless about filling his contracts when prices are rising and so contributes to the injurious short-time relation between demand and supply.

MAGNETIC TESTING OF IRON AND STEEL.

The society's Committee G, which is in charge of this subject, submitted a progress report through its chairman, Prof. J. W. Esterline. This report describes a number of careful tests made on cast-steel and cold-rolled soft steel rings of various sizes to determine their permeability. The object was primarily a comparison of the best standard methods of determining permeability, and a study of the influence of size of specimen. Neither of these two objects has been fully attained as yet. The variation found between different methods of testing was such as to make it seem of great importance to establish a standard method of testing for permeability. The committee will continue in this line of work.

Two papers on the same subject were presented in conjunction with this report. Mr. C. E. Skinner (East Pittsburg, Pa.) read a paper on "The Commercial Testing of Sheet Steel for Electrical Purposes," and Mr. H. E. Diller a paper on "Permeability of Cast Steel." Mr. Skinner described briefly the procedure of testing sheet steel (for armature and transformer cores) at the works of the Westinghouse Electric & Mfg. Co., East Pittsburg, Pa. Besides frequent chemical analyses, the material is tested for "core losses," i. e., hysteresis and eddy-current losses, by two methods, the armature and the transformer methods. The former determines the losses mechanically, the latter electrically. The paper of Mr. Diller gave the results of some tests on cast-steel bars, made with a view to finding the influence of various chemical elements in the metal on the permeability.

The carbon and manganese, as might be supposed, have a very harmful affect on the permeability. Not 0.45% of manganese lowered the permeability of annealed steel only 1%. The results would seem to indicate that a substantial increase in permeability cannot be gained by additions of silicon or aluminium unless they are added to the extent of several per cent. Considerably more than 2% of phosphorus would be required to affect the permeability to a marked degree. But at least it seems safe to remove the upper limits for these three elements in specifications for cast steel for dynamo work, so far as their effect on the permeability is concerned.

Some general discussion of the subject which followed brought out that there is no satisfactory explanation for the "aging" of steel, i. e., its decrease in permeability during long-continued low heating; that physical condition and heat treatment of steel have great influence on the permeability and the aging; and that in cast dynamo frames the area of metal is always large enough that little attention need be paid to permeability. There appears to be a large field of work open to the investigation of the relations between magnetic properties, composition, heat treatment, etc., of steel.

THE NICKED-BENDING TEST FOR STEEL.

A paper by Mr. J. P. Snow on "Proposed Tests for Controlling the Heat Treatment of Structural Steel," in which a nicked-bending test of crop ends of plates and rolled shapes is suggested, caused quite a bit of discussion of bending tests, a subject which also came up to a slight extent during the preceding day's discussion of Iron and Steel Specifications. Mr. Snow proposed to shear a 12-in. strip from the crop end of each rolled piece, nick it across the grain in a standard manner, and bend it over at right angles in a hydraulic press. His object is to open the grain of the metal, revealing brittleness if present, and also giving an indication of segregation and heat treatment. The test is offered as a suggestion, and the author concedes it to require very careful investigation before its value can be estimated. It brought out much discussion, which in general was favorable to a bending test of some kind. Many doubted, however, whether it is necessary to test every piece rolled, as suggested by Mr. Snow. The author's main argument for the test is that it is very rapid, requires no machinery, and may give valuable information, especially in revealing the dangerous brittleness which is sometimes found in rolled steel rails and structural shapes. The test gives its results "before the rolling-heat has left the piece."

The paper was discussed in conjunction with a paper of Mr. W. R. Webster on "Tests for Detecting Brittle Steel." Mr. Webster also acknowledged the importance of some reliable test for brittleness, which quality is usually not revealed by tension tests. In the preceding day's discussion Mr. Webster had made an argument for careful consideration of a nicked-bending test. In this paper he made the further suggestion that a microscopic examination of a small polished spot on the surface of the piece might suffice to indicate dangerously large grain. Mr. Albert Sauveur (Boston) did not believe that any information of value could be gained in this way. He does not believe that the time has come when microscopic study can be introduced into steel testing. Mr. H. H. Campbell (Steelton, Pa.) gave the practical objection to the microscopic test that it would be far too slow for commercial purposes. The nicked-bending test, however, he thought

might be a move in the right direction, though at present too little is known of it in detail to allow of precise opinion of its value. Mr. James Christie (Wissahickon, Pa.) recalled a test suggested by Mr. A. W. Hunt at the Chicago Congress in 1893—to make a graphic record of the force required to punch a hole through a piece. The variation of pressure in this process differs materially for brittle and ductile materials, sufficiently so to make the test a good indication of brittleness. Mr. Christie suggested the addition of a drifting test following the punching test; some years ago he designed a machine to make these tests, but on the death of Mr. Hunt discontinued the matter.

The final day's proceedings opened with a preliminary report of the Committee on Standard Tests for Road Materials, by its chairman, Mr. L. W. Page (Washington, D. C.). This report recommended the adoption of an abrasion test for macadam, which test was passed by the meeting for letter-ballot of the society. The specifications for the abrasion test are as follows:

This well known test is similar in almost all respects to the Deval abrasion test of the French School of Roads and Bridges. It has been used since 1878 and is entirely satisfactory for the purpose for which it was designed.

The machine shall consist of one or more hollow iron cylinders, closed at one end and furnished with a tightly fitting iron cover for the other; the cylinders to be 20 cm. in diameter and 34 cm. in depth, inside. These cylinders are to be mounted on a shaft at an angle of 30° with the axis of rotation of the shaft.

At least 30 lbs. of coarsely broken stone should be available for a test. The rock to be tested should be broken in pieces as nearly uniform in size as possible, and as nearly 50 pieces as possible should constitute a test sample. The total weight of rock in a test should be within 10 grams of 5 kilograms. All test pieces should be washed and thoroughly dried before weighing; 10,000 revolutions, at the rate of between 30 and 33 to the minute, must constitute a test. Only the percentage of material worn off which will pass through a 0.16 cm. (1-16-in.) mesh sieve should be considered in determining the amount of wear. This may be expressed either in the per cent. of the 5 kilograms used in the test, or the French coefficient, which is in more general use, may be given; that is coefficient of wear $= \frac{400}{W}$, W being the weight in grams of the detritus under 0.16 cm. (1-16-in.) in size per kilogram of rock used.

The sub-committees on Asphalt Tests, Wood Paving Blocks, and Road Building Problems, have not yet submitted a report.

TENSILE IMPACT TESTS OF STEEL.

A very valuable paper on this subject was presented by Prof. W. K. Hatt (Lafayette, Ind.), giving the results of several years work. We hope to give a full abstract of this paper in the near future. For the present it may be sufficient to say that the tests were in all cases comparative tests between gradual breaking and sudden breaking, the latter being arranged in ingenious manner by the blow of a weight whose speed at all instants was recorded on a drum. The final elongation in 8 ins., and the work of rupture were recorded. Briefly the results are that the elongation is slightly greater in most cases with impact fracture, as is also the work of rupture, but this difference is evidently on the safe side. This applies to smooth straight bars only. Experiments were begun on nicked, rasped and rough bars, but were not carried very far It seems to be indicated that the ductility falls off very rapidly in rasped bars, and disappears almost completely when the bar is nicked. Experiments were also made to determine the effect of heat and cold, on soft steel and nickel steel. The maximum strength and ductility, under impact test, were found at about 0°F., dropping off both ways from this point but more sharply with lower temperatures.

A paper was read by Mr. P. Kreuzpointner on "The Desirability of a Uniform Commercial Speed for Testing" in which the author argued that great differences may be obtained in tensile tests by changing the speed of breaking, and that therefore a standard speed of applying the load should be established. As Mr. Hatt's paper demonstrated that for smooth bars there is little difference between the results of gradual breaks and of impact breaks, this plea did not find much favor. It was acknowledged that great differences in test results on the same material were found, but these are attributed more to the general manipulation of the testing machine than to the speed of testing. However, the suggestion of the author was referred to the Executive Committee for consideration.

The meeting closed with several papers which may be passed over briefly. Mr. Albert Sauveur (Boston, Mass.) in a paper entitled "Nomenclature of Iron and Steel" gave the reasons against the German nomenclature, which distinguishes steel from wrought iron by percentage of carbon. He concludes that it is most proper to differentiate steel from wrought iron by process of manufacture, one being produced in fluid, the other in pasty condition. Wrought iron running over 0.25% of carbon might then be called "steely wrought iron." Mr. Wm. Metcalf (Pittsburg, Pa.) added to this paper the remark that the German name "flusseisen" for mild steel was adopted merely in order to get the material into this country on the wrought-iron tariff.

Mr. H. V. Wille read a paper on "Staybolt Iron and a Machine for Making Vibratory Tests." This paper describes a new machine of Tinius Olsen & Co., by which staybolts may be tested for resistance to combined tension and alternate bending. The tensile load is automatically kept at a constant amount during the test; the bending may be adjusted to any amount, from 0 to ¾-in.

Mr. T. D. Lynch (East Pittsburg, Pa.) described "A New Chuck for Holding Short Test Pieces," by means of which tensile tests may be made on pieces as short as 2⅞ ins. The test piece is made with an enlarged head, which is held by fingers on the chuck. Much shorter test pieces can be used with this method of holding than with the standard threaded end.

A paper on "Bending Moments in Rails," by Mr. P. H. Dudley, was read by title only, and was not discussed.

THE WELL DRILLER FOR DRILLING BLASTING HOLES.

An account of the use of well drillers for boring blasting holes appeared in our issue of Sept. 24, 1903, p. 275, which, so far as we know, was the first published description of the use of this type of machine for railroad excavation work. In the work on the Pennsylvania R. R., described in that article, well drillers having the ordinary 5⅝-in. bits were used, and we made the suggestion that a special set of tools having a 3-in. bit would doubtless prove far more effective for the comparatively shallow holes required in blasting. Whether acting under this suggestion or not, it is interesting to note that a well-driller using a 3-in. bit is now on the market, having been designed by The Cyclone Drilling Machine Co., of Orrville, Ohio.

We are indebted to Mr. W. M. Douglass, of the contracting firm of Douglass Bros., New Alexandria, Ohio, for some valuable data relating to the work done by this driller on the excavation work being done by that firm for the Wabash R. R. in eastern Ohio.

In drilling solid brown sandstone the holes were put down to a depth of 24 ft. with a 3-in. bit, and the drill averaged two such holes per day of 10 hours. The cost of labor, fuel, and water was about 12½ cts. per ft. of hole drilled. In the blue sandstone, which is softer, an average of 60 ft. per day was drilled. To show the saving in cost effected by the use of the well driller, it will suffice to add that in the brown sandstone the cost has been 38 cts. per ft. of hole, the holes being 20 to 30 ft. deep drilled with churn drills by hand. Up to depths of about 20 ft., and in stone of no greater hardness than this sandstone, the ordinary steam drill will put down holes at slightly less cost, but a factor that more than offsets this slight advantage in cost, is the difference in the size of hole. The well drill holes being large (3 ins.) are never "sprung" more than three times in this sandstone, whereas the steam drill holes, being small (1¾ ins.), must be "sprung" four or five times.

Where rock is to be loaded with steam shovels there is a great advantage in working to a high face, and with well drillers it is feasible to drill holes for a face 60 ft. or more in height. Indeed one shovel on the Pennsylvania R. R. was working to a face of shale 65 ft. high, as described in the article in our issue of Sept. 24, 1903.

For deep holes, and particularly in shales and sandstones that are of moderate hardness, the well driller with a 3-in. bit is a machine deserving of extensive use.

TRAFFIC THROUGH THE SUEZ CANAL in 1903 amounted to 17,246,681 tons, an increase of 658,875 tons over the preceding year, and nearly 50% in excess of the traffic in 1896. The receipts from tolls were about $20,000,000, a little less than that of 1901 and 1902, owing to a reduction in tolls. The total number of vessels passing was 3,761, of which about two-thirds were of British registry.

THE MOST SERIOUS RAILWAY ACCIDENT of the week occurred on the Boston & Maine Ry., near Plymouth, N. H. A passenger car in a mixed train became derailed on a bridge and was crushed by the car behind. One passenger was killed.—Two through passenger trains on the Baltimore & Ohio R. R. collided June 16 near East St. Louis, Ill., killing one of the trainmen.

RECORD SPEED was made by the North German Lloyd steamer "Kaiser Wilhelm II." in an eastward trip across the Atlantic in the week June 14-June 20. The vessel made the distance between Sandy Hook Lightship and Eddystone Lighthouse in 5 days, 11 hours, 58 minutes, steaming 3,112 nautical miles. The average speed was 23.58 knots. This is the highest recorded average speed for a vessel on a long distance.

TYPHOID FEVER has been prevalent in Indianapolis for the past six weeks. From Dr. C. E. Ferguson, Acting City Sanitarian, we learn that the Department of Public Health has not yet determined the source of the infection. "The disease is so well distributed over the city as to point to a general infection from a common source. We cannot trace it to drains or milk, and are now investigating the water supply."

The following figures are also furnished by Dr. Ferguson:

	No. of cases.		No. of deaths.	
	1903.	1904.	1903.	1904.
April	26	35	4	10
May	12	202	4	23
June 1 to 10	..	92	..	..

During the months of March and April a large section of the city was flooded three times; and other portions were flooded twice. In one section the water stood 2½ to 3 ft. deep. The water also backed up in the sewers, and one of the large main sewers is still completely choked, so that the sewage is flowing into Pogue Run, along which much of the sickness has occurred.

The present water supply of the water company is obtained from deep wells, and will be augmented before a great while with filtered water. During the high floods, the levee was washed out which protected the pumping station, and caused the flooding of the station. For a few days the company was obliged to supply river water.

TO MEASURE CURRENT VELOCITIES by direct integration for an entire vertical filament of the cross-section of a channel, Mr. S. Hajós, a Hungarian engineer, proposes a novel method which is at least theoretically interesting. The principle is as follows: If a body of specific gravity less than 1 is released at the bottom of the channel, it will rise to the surface and simultaneously be carried downstream. The downstream force exerted upon it at each point will be proportional to the velocity at that point. Consequently the total departure of the body from a vertical, during the time of its rise, will be the integral of velocity times time, for the whole vertical filament, during the time of rise. Dividing the distance which the body has moved downstream by the time of rising gives the average downstream velocity of water in the vertical filament. It is proposed to apply this principle by releasing a ball of wood, celluloid, or hollow brass, at the bottom of the channel from a trap, at a noted instant of time, and then noting the moment at which it appears at the surface. The distance of "departure" may be measured by a floating graduated rod, extended downstream from the vertical rod (or sounding rope) where the ball was released. If lateral departure is to be expected, so that the precise distance from the starting point may not be measured exactly in this manner, it is suggested that a horizontal net set in a wooden frame may be spread on the surface of the water, to catch the ball at the moment it reaches the surface; this would allow the true departure to be measured quite accurately. The author of this principle made some experiments on the time required for different bodies to rise from different depths. He found that the time varies with the specific weight and with the diameter of the ball, but in still water is constant for a given diameter and given specific weight. The time of rise varies directly with the depth. In currents of any appreciable velocity it was found that the disturbance is great enough to make it necessary to measure the time of rise directly, instead of computing it from the (known) depth of water.

A DIVISION OF TESTS is to be established in the Bureau of Chemistry of the U. S. Department of Agriculture. The work of this Division will be the testing and investigation of road materials and all materials of construction relating to agriculture, and to do such testing work for other Departments as the law may require.

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ADVERTISING RATES will be furnished upon application. "Want" and "For Sale" notices (special rates), see pages 26-27. The pages for new "Want" "Proposal" and "For Sale" advertisements are held open until Wednesday noon.

A civic museum is suggested by a correspondent in the "Tribune," of this city, as a fitting memorial of the late Andrew H. Green. In itself the museum idea is an excellent one; and such a depository of all that has a bearing upon the history and growth of New York would certainly be a most appropriate means of perpetuating the memory of one who probably did more than any other citizen in furthering the material interests of this city and in creating the Greater New York.

But, as before said, the suggestion for the creation of a civic museum in this city is one in itself well worthy of consideration. By such a museum is meant a place especially devoted to the collection and preservation of all material marking successive stages in the growth of the city, including in this case relics of the Indian occupants of Manhattan Island as well as exhibits showing development in the domestic, social, industrial, professional and military life of the Dutch and English colonists who supplanted the red man. The material is abundant enough, though widely scattered; all that is needed is a fitting storehouse and the organization of a staff that would intelligently gather and classify it. Museums of this type are abundant in Europe, and they are a never-ending source of interest to the Americans who visit them. How much greater would be this interest if each exhibit had a direct bearing upon the life of our own immediate ancestors and formed part of our own history. The well arranged and rich collection in the Musée Carnavalet does this for Paris. It enables the Parisian to study the history of his own city, from the Roman foundation down through the centuries, illustrating each period with relics of many kinds relating solely to Paris. In our case, the period of time covered would be much shorter, but, for this reason, the chain of our exhibits should be much more complete.

What may be called the engineering development of New York would alone make a most instructive and interesting department. A full collection of maps, showing the growth of the city from its start at the Battery to the Greater New York would form a fitting basis for this department. Other features would be the history of the introduction and distribution of water and gas, the development of buildings, the different methods of transportation adopted at various times in our streets, public works of all kinds, as illustrated by models, our school system, park system, and practically all that relates to the municipal management of the city. As such a collection would illustrate the blunders as well as the successes of city control, it would be an object lesson in municipal development, very useful to ourselves and instructive to others. New York is now old enough to possess a museum of this nature, and we believe that in public interest it would not be surpassed by any of the many rich collections of a different type now open in this city.

The attention of contractors is called to a short article in this issue from an Australian engineer, in which the use of a hoisting engine for loading wheelscrapers is described. The substitution of an engine for a "snatch team" is an expedient well worthy of adoption wherever the soils are moderately tough and the hauls moderately long. There are two features described in the article that are, so far as we know, novel. The first feature is the use of a boy on a pony for unwinding the wire cable and for moving the free end of the cable from place to place as desired. The second feature is the use of a third wheel to relieve the horses' necks of pressure during loading. This feature might be adopted even for wheelscrapers not intended for use with a hoisting engine; for it is well known that the necks of pole teams on scrapers are subject to severe pounding during loading, as well as during dumping of scrapers. The injury of horses by this pounding, as well as their "jumping into the collar" at the time of loading, has stopped the use of wheelers by many owners of horses. With the aid of a hoisting engine and the use of some device to relieve the necks of the horses from downward pressure, it is apparent that the field of usefulness of the wheeler may be greatly extended. Heavier scrapers, to withstand the greater strains put upon them by an engine, will have to be manufactured; but the increased cost will be quickly returned by the increased size of loads that they will carry. Scraper bowls are now limited in size entirely by the tractive power of the horses at the time of loading. The dead weight to be hauled after loading is usually not more than half what a good team can pull. If any of our readers have used hoisting engines for loading wheel-scrapers we should like to hear with what measure of success engines have been used in this country.

One of the most creditable practical developments of recent experimental studies of reinforced concrete is the hooped reinforcement for columns which has been worked out and patented by the well known French engineer Considère. Until recently, we had supposed that this development was not only original but also unique with the brilliant Frenchman, but it now seems certain that he was not alone in the conception of providing a circumferential reinforcement against rupture under compression, and in working out a practical form for such a reinforcement. In the description of the reinforced concrete grain elevator construction published elsewhere in this issue there is illustrated and described a hooped concrete column identical in all essentials with the column devised and patented by Mr. Considère. The design illustrated is entirely original with Mr. J. A. Jamieson, a well-known practicing engineer and member of the Canadian Society of Civil Engineers. An account by Mr. Jamieson of how the invention came about is given in the article referred to above, and all that need be done here is to call it to attention. That Mr. Jamieson hit upon the idea of hooped concrete and worked it into form for practical use in construction is a fact deserving of full recognition by engineers, particularly since he is precluded from a share in the financial emoluments of the invention.

THE LESSON OF THE "GENERAL SLOCUM" DISASTER.

The civilized world has been horrified during the past week by the published accounts of the terrible holocaust on board an excursion steamer in the East River at New York City, resulting in a loss of life which almost excels all records of marine disaster or of loss of life in fires on land. The exact number of those who perished as a result of the burning of the "General Slocum" will never be known. From the record of bodies recovered (at this writing 727) with the number of those reported missing and supposed to have gone on the excursion and making allowance for the undoubted cases where whole families were wiped out and none left to report their loss, it seems certain that the total loss of life will exceed 900. To enable the reader to appreciate the magnitude of this disaster, it may be noted that it exceeds the loss of life in the greatest theater fires ever recorded, as may be seen by reference to the list of great theater fires published in our issue of Jan. 7 last, at the time of the fire in the Iroquois Theater at Chicago.

As usual when any great disaster occurs, the public is at once and rightly agitated to find where the blame should be laid, and the captain, the crew, the owners of the boat and the Government inspectors are all charged in the public prints with having in some way contributed to the disaster. National, State and Municipal officers from the President down are alert that no one guilty of negligence in connection with the affair shall escape punishment, and in the hue and cry over these minor matters the great and important lesson of the "General Slocum" disaster is in a fair way to be overlooked.

What was the main cause of this great holocaust? There were minor causes, of course. Placing some hay and other inflammable material where a chance spark might start a blaze which would ignite the oil in the lamp room is said to have been one. Failure to promptly discover and extinguish the fire was doubtless another. Perhaps the hose was defective, perhaps the life preservers were unsound, perhaps the captain might have beached his boat five or ten minutes sooner at a point lower down the river. All these, however, are minor causes. The real reason why nearly a thousand persons met a violent death by burning or drowning in this disaster was because the "General Slocum" burned so rapidly that there was no time to quench the flames and no time to rescue the great bulk of the unfortunate passengers who crowded her decks. And why did she burn so rapidly? It was not because she was an old boat, not because she was overloaded, not because captain, or crew, or Government inspectors were in any way delinquent. *It was because she was built of such inflammable construction as to directly invite such a disaster as occurred.*

Further than this—and we know not how to emphasize this too strongly—the "General Slocum" was no worse a fire risk than the average river or sound or harbor passenger steamer in use all over the United States. She was a fair representative of the prevailing type. The same disaster that befell her may befall to-morrow any one of thousands of such craft plying on American inland waters, and we do not except from this the so-called finest examples of the steamboat builders' art plying on the Sound or the Hudson River.

We may strengthen our Federal inspection laws as we please, and secure their rigid enforcement by competent and incorruptible inspectors; but the finest equipment of life-saving material can avail little to mitigate the disaster if a vessel burns so fast that there is no time to launch life-boats or put on life preservers.

The typical American passenger steamboat in use on inland waters consists of a wooden or steel hull of light draft, upon which is built a light wooden superstructure extending far out over the hull on each side, and rising upward for two or three to half a dozen or more decks or stories. These stories are supported on light wooden columns, and floors, sheathing and partitions are made, as a rule, of pine or other light lumber. The whole is covered so liberally with paint that fire will run over it almost as readily as over a powder train.

Take the upper works of the "General Slocum," or of any of the finest Sound or river steamers, off the hull and place them on a building lot, in any part of New York City. Fill the decks with such a crowd as is to be seen on excursion boats on any summer's day; or instead, if it be a night boat, fill the staterooms and berths with sleeping passengers as they are filled daily during the season. Then start a fire in or underneath this vast tinder box, let it reach good headway, and then

set the New York fire department to extinguish it and save the lives of those in peril. We risk nothing in saying that the structure will be reduced to ruins before the finest fire department in the world can extinguish the flames and that the list of lives lost in the conflagration before rescue can come will fill columns in the newspapers.

No one familiar with the inflammable construction of American passenger steamers will deny that this is true; yet we place a three or four-story timber box on the hull of a vessel, send it out on the water far from the help of any fire department, and when disaster occurs try to find a scapegoat in those who owned or managed the boat or those whom the Government pays to inspect such vessels.

If this were the only possible way to build a steamboat, we should have to make the best of it. It would be necessary then to fix our attention on such makeshifts to mitigate danger as automatic sprinklers and other contrivances for checking fire at its start. We should have to console ourselves with the reflection that such great disasters as that of the "General Slocum" come very seldom, and put up with the danger as a part of the necessary risk of life under modern conditions.

But because for two or three generations since the art of steamboat construction began everybody has built steamboats in a certain way, it does not follow that that is the only possible way. Indeed, with the increasing scarcity and cost of this inflammable pine lumber, (which American builders have used so long that they have come to consider it impossible to use anything else) we shall be compelled to find substitutes. We cannot, indeed, copy directly the present practice in fireproof construction in erecting the superstructure of a steamboat; but we can use incombustible materials in constructing it, and where we are compelled to use wood we can impregnate it with fire-retarding chemicals and cover it with fire-retardant paints.

In urging a reform in steamboat construction we are speaking for no patent process or special type of construction. All we urge is that those who buy or build or design passenger steamboats should open their eyes and ears to the progress which has been made in the art of fire prevention and of construction with incombustible materials during the past twenty-five or thirty years. We do not charge the builders of steamboats with knowingly and wilfully neglecting to safeguard the lives of future passengers. They have been guilty merely of gross ignorance and blind conservatism. It has required some such stupendous disaster as this of the "General Slocum" to open their eyes to their own ignorance and warn them to turn a more receptive mind to the fruits of modern invention and research. Is it too much to hope that the lesson may be heeded?

Let us say here, too, that this is not the first time that Engineering News has roundly condemned the "fire-trap" type of steamboat construction and urged its abandonment. It is not so many years ago that a Pennsylvania Railroad ferryboat burned at her pier in Jersey City with such rapidity that a few dozen people on board had to run great risk in making their escape. We pointed out at the time that only good fortune caused the fire to break out at that particular time instead of at a time when the boat was in the middle of the river, with every inch of standing room on her decks crowded with passengers.

Again we commented, years ago, on the burning of a Fall River line steamer while lying at her pier with no passengers on board. That fire was so rapid that even the few deckhands on board were rescued with difficulty. Only a year and a half ago we again drew attention to this occurrence at a time when the Fall River passenger department announced the construction of a new "palatial, million dollar steamer," and in the description sent out for publication emphasized the fact that its interior finish was "particularly elaborate, the woodwork being pine, decorated with carving, parti-color frescoes and heavy gilding." Our comment on this was as follows:

> In other words, so far as at present appears, the new vessel will be another floating fire-trap. . . . . Why should not the Fall River Line managers heed such lessons as the burning of one of their own vessels a few years ago or the fires on the North German Lloyd steamers at Hoboken in the summer of 1900? Instead of lavishing money on a mass of "pine decorated with carving and heavy gilding," why not devote a little expenditure to safeguarding the lives of passengers? . . . .
>
> We believe it is entirely within the resources of engineers and marine architects to build a River or Sound steamer in which passengers' lives will be fairly secure against danger from fire. A large part of the upper works and interior finish could be made of incombustible materials, and where the use of wood is necessary it could be treated by some fire-retardant process. We do not urge actual fireproof construction, of course, as weight and other considerations would make many methods used in buildings inapplicable on board vessels. What we do advocate is such sensible use of present-day methods of retarding the spread of flames as shall make it possible to extinguish a fire should one start on board such a vessel, or at least enable passengers to escape with their lives in advance of the conflagration's spread.

We print this quotation to show that not once but repeatedly has this journal described in plain terms the prevailing type of steamboat construction in this country as respects the danger from fire, and that we have endeavored to utilize previous instances of actual destruction of such vessels by fire to illustrate the danger and to induce a reform in construction methods.

And let us say here that we are not urging anything unpractical. We freely recognize that security against fire is only one of very many practical considerations which confronts the marine architect. We freely recognize that on shipboard, fireproof construction—or let us better say fire-retarding construction—will necessarily be considerably less fire-resistant than fireproof construction on shore, where weight is a matter of secondary importance. But when the marine architect does the best he can do within his limitations—when he makes practical use of the knowledge and experience that have been accumulated in other branches of the engineering profession, he will produce a structure far more resistant to the spread of flames than the present type of American steamboat for inland waters. With this will be coupled such an extension of the use of fire extinguishing apparatus, such as automatic sprinklers for storage rooms where fire is likely to originate, that the chances of quelling a fire at its start will be greatly increased.

Of course we are well aware that radical reforms are only made slowly; and we are not sanguine enough to expect any considerable change in the methods of steamboat builders as a result of the "Slocum" disaster. The public will display a nine-days' eagerness to visit punishment on those whose neglect may have contributed some small part to the magnitude of the disaster, overlooking entirely the greater lessons involved, and then the whole matter will give place to some new topic of public interest.

What we do hope is that this great calamity may serve as an incentive to that small element of intelligent and progressive men, with whom always rests the burden of beginning any innovation on past practice. We hope to see a few progressive owners of passenger vessels, a few marine architects, and one or two builders of steamboats summon the courage to break with past traditions and design and build a few vessels in which especial care shall be taken to prevent fire. When once the way is thus marked out, when a precedent is established and made successful, dozens will make haste to follow it and the foundations for a rapid reform will have been laid.

LETTERS TO THE EDITOR.

Corrosion of a Steel Stack.

Sir: Referring to the communication of "Pocahontas" in your issue of May 26, relative to the corrosion of the interior of a high stack, I have inquired into this matter and learn the probable reason for the stack corroding at the middle of its height is due to the fact that that is the point at which the gases condense and settle on the steel. Up to that point the acids and ammonia have been in a gaseous state, and when they condense they settle on the steel and affect it very much more at that point than they do further up the stack.

Wrought iron would last very much longer than steel in a stack of this kind. A paint made of graphite as a base, with a vehicle especially manufactured to meet the conditions, would probably be the best protection possible. Even this would not be a permanent protection. Two or three coats of the paint should be applied, allowing ample time for each coat to dry.

If the author will write to me, 42 Hudson St., New York City, I should be glad to communicate with him.

Yours very truly, W. A. Polk.

New York, June 13, 1904.

Dredges for Swamp Excavation.

Sir: In reading the paper in your issue of June 9 describing the clearing of a lake, reminded me of a case where several miles of swamp was required to be deepened two or three feet, and numerous large stumps, trees, undergrowth, etc., removed.

The best and cheapest plan suggested, was to flood the entire site to sufficient depth to float a dredge, and with this, dig pits, 7 ft. or more in depth, into which all the stumps and objectionable matter was to be dropped. The remaining good material was then used to grade. At one part of the site there were several thousand cubic yards of good soil, although wet, which was to be excavated to a depth of only 2 ft. and distributed along the banks of the proposed lake, this it was proposed to also dredge, and then by means of scows and a small tug to place it where required.

Yours truly,

T. H. McCann.

Second Nat. Bank Building, Hoboken, N. J., Hoboken, N. J., June 14, 1904.

A Common Error in Calculating the Degree of Turnout Curves.

Sir: It has recently been clearly shown in your columns that an error, though not vital, has always been made in calculating superelevation of out rail of curves. Attention is now called to a common, material error in calculating the degree of turnout curves, an error amounting to about 20% in excess, due to making such curves tangent to the point instead of to the heel of frog where the curve really begins.

Turnout curves are useless until after the frog is passed, since frogs and split rails are not made to fit a curve, but are straight.

If the curve does not extend beyond the frog it is immaterial to what part of the frog it is made tangent, but when it does extend beyond the frog, as in the case of a Wye track, it should at least be tangent to heel or end of frog away from headblock, and for convenience should also be tangent to the main track. I append a statement of such curves applicable to such standard frogs as I have occasion to use. When the problem is stated as above it is a simple matter to extend the table.

Frog number	10	8½	7	6
Length, point to heel, ft.	9.25	8.75	6.5	6.0
Spread of heel, ft.	.93	1.03	.93	1.00
Degree of turnout curve	5° 03′	6° 53′	10° 18′	13° 50′
Length of turnout curve to heel, ft.	113.1	97.9	79.3	68.1
Tangent dist. of turnout curve to heel, ft.	5 6.6	49.0	39.7	34.5

The lead or frog distance is an entirely separate and distinct problem, correctly stated in Engineering News, April 21, 1898, by Wellington B. Lee, M. Am. Soc. C. E., and no where else that I have been able to discover.

Yours truly, A. M. Haynes.

608 Deseret News Bldg., Salt Lake City, Utah.

Concerning Hydrographic Surveying.

Sir: While the methods of surveying described by Mr. Cooper, in your issue of May 19, are good, they do not seem to present any very novel features, excepting the use of two leadsmen sounding alternately on opposite sides of the boat. This covers the ground very closely at a slightly increased expense, and for the particular kind of work in which Mr. Cooper appears to have been engaged, it is excellent.

No sufficient reason is shown to justify him in claiming for his method such universal applicability, and superiority to that described by Mr. Bacon in Engineering News of March 26, 1903.

Practically all of Mr. Bacon's method's although doubtless without his knowledge, have been used at Charleston Harbor for many years. They are well adapted to harbor surveying when the areas are large or the distances from shore are great, and where it is necessary to survey the same area often in order to determine progressive changes. The use of two transists in this work is entirely practicable and more precise, but sextant locations are sufficienly accurate when the scale of the map is necessarily small. This being true, why should greater precision be desired?

The advantages of sextant locations are the complete control of his party which the chief thus has; the saving of time needed to place transitmen on station and to take them off after the day's work is done; and the freedom left to the boat party to work in any part of the area to be surveyed. It will often happen that the transitmen are placed with the idea of working at a certain locality, but a sudden change in weather conditions makes it desirable to work at another. Assuming the sextant signals to be properly arranged, the chief of party is free to change his plans without the necessity for moving his instrumentmen.

It requires considerable skill to use the sextant well in a moving boat and especially in rough water, but this skill once acquired the hydrographer generally prefers it to all other instruments wherever its use is possible. The writer has used it for years and does not regard "it dangerous to use where anything like accuracy is required." Respectfully, James P. Allen.

Charleston, S. C., May 30, 1904.

The Sanitation of Contractors' Camps.

Sir: I wish to call your attention to the wretched sanitary condition of many of the contractors' camps on the lower Truckee river, where work is in progress on the government irrigation canal.

These camps are all situated within a few rods of the river, and are near the line of the Central Pacific between Derby and Wadsworth, Nevada. There are six or seven camps at present. The one at which I worked had over 200 men and is probably the largest.

At that camp there were no privies, human excreta being, as a rule, deposited near the banks of the river, and sometimes actually in the river. Flies were plentiful and could easily carry any germs present to the food the men ate, little precaution being taken to prevent their getting to it. The water for cooking was obtained from a well near the creek, but the water carried up to the men at work was obtained directly from the river. At some camps all the water used came from the river. At one camp, I saw a privy. In general, every facility is present for the spread of typhoid.

The wages of the men were docked regularly for a hospital fee. The hospital at one camp was a miserable wooden shed swarming with flies. There was supposed to be a company doctor, but I saw few traces of him.

Several physicians in Reno were seen about the matter, but they said that the State Board of Health had been shorn of all real power by the last Nevada legislature. The engineer in charge of the Geological Survey at the place, stated that he had recommended a number of improvements in the sanitary conditions but they had not been acted on as yet, and he could not force them to do anything.

Thus there appears to be nothing to do but to trust in the dry climate and the bare chance that no one of the "hundreds going," to quote the employment agencies, will bring typhoid into the camps. If that trust is misplaced—well, the outlook is not pleasant. And it seems a pity that the U. S. Geological Survey, which has done so much to prevent the pollution of rivers should not be able to do something in this case.

Yours truly, A. T. Parsons.

San Jose, Cal., June 9, 1904.

(It seems to us that the above letter may well raise the question whether the engineer in charge of contract work should not provide in his specifications for proper sanitary provision and discipline by the contractor. A few careful engineers are already inserting provisions relating to sanitation in contracts for works relating to water supply; but ought not such provisions to form a part of all contracts where work is to be done by large gangs of men in the field? It costs a mere trifle to provide decent sanitation for a camp and the only reason it is omitted is through simply neglect and ignorance of the possible consequences. The engineer, however, is not, or ought not to be ignorant in this matter; and he ought to reserve the power to compel the contractor to do what it is really for his own advantage to do as an insurance against illness among his men.—Ed.).

Notes and Queries.

Mr. D. L. Ellis, City Engineer, Great Falls, Montana, wishes the address of makers of some electrical apparatus for indicating at a pumping station the height of water in a stand-pipe located 3½ miles distant.

We have illustrated in past volumes of Engineering News a number of styles of high-water and low-water electric alarms for this purpose, but recall no example of an instrument to give a continuous record of the height. If any of our readers know of such an instrument we shall be pleased to hear from them.

THE BURNING OF THE EXCURSION STEAMER "GENERAL SLOCUM" IN THE EAST RIVER, NEW YORK CITY.

The wooden steamboat, "General Slocum," long familiar to New Yorkers as an excursion boat, was destroyed by fire on June 15, with a loss of life, of 900 to 1,000 persons. The vessel had taken on board an excursion party of Sunday school children, their teachers and parents, numbering altogether probably over 1,500. The start was made from the foot of Third St., on the East River, and the route to be followed was up the East River and along Long Island Sound to Locust Grove, a well-known picnic resort.

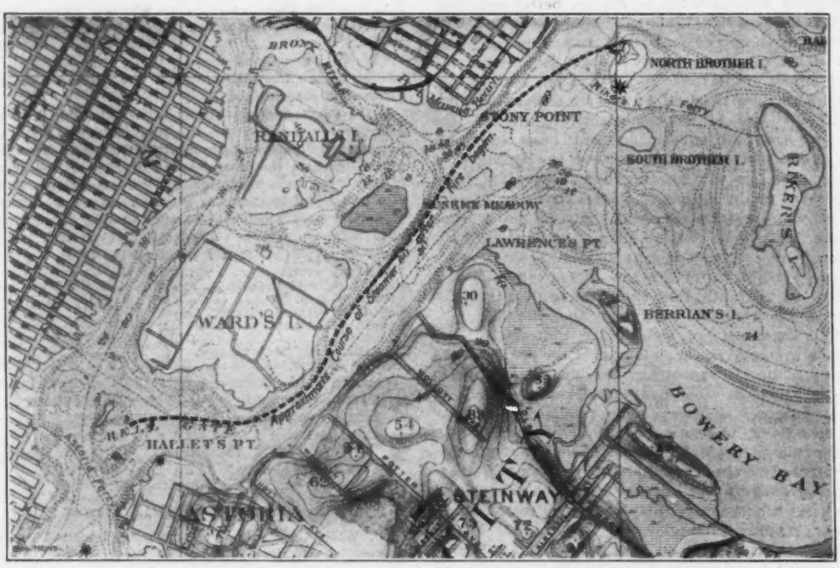
Fire started, according to the most reliable accounts, in a room used for storing lubricating and lamp oils, awnings, rope, etc., located on the lower deck forward. The room was open and a couple of barrels of hay in which glasses had been packed was thrown in the room just as the boat started. It is not improbable that a match or cigarette stub, carelessly thrown, may have fallen into this. The fire was discovered by one of the crew apparently about the time the vessel was passing through Hell Gate. Attempts are said to have been made first to smother it and then to put on a hose stream; but the latter, if applied, was ineffectual to check the flames. Apparently the Captain in the pilot house did not learn of anything serious until the flames were beyond control, the vessel being then probably nearly opposite the Sunken Meadow, shown on the accompanying map. By this time the flames had attacked the whole lower deck, fanned by the strong wind aft; and their further progress was inconceivably rapid. Those of the passengers and crew who were on the lower deck jumped overboard or fled to the upper decks, where the flames quickly followed them.

The route sailed by the vessel from the point where fire was discovered to the point where she was beached is indicated on the accompanying map. According to the story of the captain, North Brother Island was the first available point at which he considered that he could beach his boat without danger of foundering.

During the last few minutes of the vessel's progress the passengers were rapidly driven overboard by the flames or were perishing on board the vessel. When she reached the shore nearly the entire superstructure was ablaze and the boats that hastened to rescue could only pick up such of those still alive as cast themselves into the water. Shortly afterward the upper decks, overcrowded and with their supports eaten away by the fire fell into the furnace beneath.

From the time when the fire in the store room got beyond control until the whole vessel was in flames appears to have been only a very few minutes, too few for any attempt to launch a life boat, even if it could have been done in the midst of the panic-stricken crowd already attacked by the fire, and too few for more than a few of the passengers to seize life preservers and put them on.

On Tuesday, June 21, six days after the disaster, 721 bodies had been recovered of which 625 had been identified and 230 were still reported as missing. This would indicate a probable total dead of about 850, but there were, it is probable, whole families swept away; and no one left to inquire for them, so that the total fatalities will probably exceed 900.



MAP OF EAST RIVER, OPPOSITE NORTHERN PORTION OF MANHATTAN ISLAND, SHOWING COURSE OF STEAMER "GENERAL SLOCUM" FROM POINT WHERE FIRE WAS DISCOVERED TO POINT WHERE SHE WAS BEACHED.

(Reproduced from Bien's "Metropolitan District Atlas;" Scale: 2 ins. = 1¼ miles.)

ELECTRIC RAILWAY TESTS AT THE ST. LOUIS EXHIBITION.

The electrical department of the St. Louis Exhibition decided some time ago to take advantage of the opportunity to conduct certain service tests of electric railway apparatus, in order that important scientific and engineering information might be compiled for the benefit of designers and engineers in meeting the engineering questions which are now arising in the problems of electric railway equipment and operation. The commission appointed to make the necessary arrangements and plans is composed of the following members, all of whom are from New York, with the exception of Mr. McCulloch, of Indianapolis; J. C. White, H. H. Vreeland, W. J. Wilgus, James H. McGraw and George F. McCulloch. This commission appointed four committees, as follows:

1. Tests of City and Suburban Equipments: M. G. Starrett, Chief Engineer, New York City Ry.; D. F. Carver, Chief Engineer, Public Service Corporation, Jersey City; W. S. Twining, Chief Engineer, Philadelphia Rapid Transit Co.

2. Tests of Interurban Equipments: A. L. Drum, General Manager, Indiana Union Traction Co.; Charles Jones, Chief Engineer, Aurora, Elgin & Chicago Ry.; C. A. Alderman, Chief Engineer for Appleyard System of Electric Railways (Ohio).

3. Tests of Heavy Traction Equipments: W. J. Wilgus (New York Central Ry.), F. J. Sprague and F. P. Slater (Assistant Engineer, Interborough Rapid Transit Co.).

4. New Electric Railway Systems: B. J. Arnold, Paul M. Lincoln (Westinghouse Electric & Mfg. Co.), W. B. Potter (General Electric Co.).

A full meeting of the Executive Committee, appointed to determine the nature and scope of the tests, was held at St. Louis in May. The committee consists of Prof. W. E. Goldsborough, Chief of the Department of Electricity, Chairman; Prof. H. H. Norris, Cornell University, Superintendent of Electric Railway Tests; Prof. B. V. Swenson, University of Wisconsin, and Prof. H. T. Plumb, Purdue University, Assistant Superintendents. After careful study of the reports of the engineering committees, of the suggestions of the advisory committee, and of the facilities afforded by the Exhibition officials, the Executive Committee decided to undertake the following series of tests:

1. Tests on the service capacities of electric railway motors.—Equipments will be operated upon the special tracks at different rates and duration of acceleration, coasting and braking, with different lengths of stops, in order to determine the heating of the motors, under conditions approaching as nearly as possible those of com-

mercial practice. The motors will also be tested separately for heating, and for the determination of their torque curves and accelerating powers. This will render possible the comparison of the performance of the same equipment upon the track and upon the test stand.

2. Acceleration tests, upon single cars and upon trains equipped with the multiple system, will be made to determine the ability of the equipment to bring the cars to speed quickly and economically.

3. Braking tests upon single cars and trains as above will be conducted in order to determine the quickness of action, the shape of the braking curves, the relation between the braking forces and the applied pressures, and the best methods of the application of the braking force.

4. Determination of the resistances due to the rails, to the journals and gearing, and to the air, will be made by systematic and complete series of runs. The effect of the shape of the car body will be carefully investigated. The methods to be used in measuring train resistance comprise the use of calibrated motors as the source of power, the hauling of the car under test by calibrated dynamometers, and by noting the falling off in speed while the cars are coasting. The pressure of the air upon different parts of the car will be recorded by means of self-registering pressure gages.

In addition to this definite series of tests, a number of other tests will be conducted upon various exhibits in the Electricity Building in order to determine their efficiency and reliability. The tests described in the first three sections above will be conducted upon the tracks which have been built for the purpose by the Exhibition. These are of substantial construction, conveniently located, and of a total length of about 4,500 ft. For the high-speed tests described under the fourth section, the Indiana Union Traction Co. has provided a stretch of eight miles of straight and well-ballasted track. The resistance tests will be made after the completion of the St. Louis program. In all of the above work graphical records of the measurements will be obtained by the use of autographic instruments.

For the purpose of comparison, the various railway equipments will be divided into several classes, including car weights up to 45 tons, as follows: A, light city service; B, heavy city service; 3, light interurban service; 4, heavy interurban service. The actual work of observation and calculation will be carried on under the supervision of the superintendents by a corps of young men carefully selected from among the graduates of the leading technical schools. It is expected that three superintendents and from 25 to 30 assistants will be engaged on this work for at least three months.

TESTS OF INTERURBAN RAILWAY EQUIPMENT.

This committee recommended that tests of systems of control, or controlling apparatus, be made in conjunction with outdoor tests of railway equipments on the experimental track, with the possible exception of tests made to determine the electrical energy required for operating multiple-control systems, and that shop tests be made on the different systems of multiple control to determine the electrical energy required to bring the control to the "full on" position in different lengths of time, and also the energy required to hold the control at "full on" position. With this data, it will then be possible to determine the relative economy of the different types of control, as well as the total power consumption of any type under any given conditions of train operation. The tests should be made with cars having four motors of 75 HP., for although some of the high-speed lines now have cars with four motors of 125 HP., the consumption of current and the amount of force are excessive, especially when the motormen turn the controller handles too quickly. The sudden application of such enormous power causes severe strains in the motor, gearing and axles, and it is thought that for economical service the four 75 HP. motors are amply sufficient. The following is an abstract of this committee's report:

TESTS ON EXPERIMENTAL TRACK.—As the Commission will probably have time to conduct a series of tests on only one type of this equipment, we recommend that the experimental equipment consist of the following: 1, standard interurban car body, weight 16 to 20 tons, exclusive of trucks and motors; 2, standard pair of interurban trucks, weight 8 to 12 tons per pair; 3, standard direct-current railway motor equipment, consisting of four 75 HP. motors, with such different types of hand and train controlling apparatus as are available. The above type of car will weigh complete (including car body, trucks, equipment, and average live load) from 35 to 40 tons.

The experimental tracks at the Exhibition will consist of two parallel tracks 1,400 ft. in length and two parallel tracks 2,000 ft. in length. The first two lengths of track mentioned are not long enough to permit tests that will be found to be desirable, and we recommend that the Commission endeavor to secure the use of the three-mile track, as this length of track will make it possible to obtain test conditions furnishing data of greater value than may be secured on the shorter tracks.

In general, the three points in regard to which the least accurate information is available are as follows: 1. The relation between the average electrical losses in the motor and the rise in temperature attained under various conditions of high speed service. 2. The train resistance (or power required to propel a car or train at uniform speed) at very high speeds. 3. The performance of cars equipped with controllers so arranged that the acceleration is automatic, as compared with the performance under similar conditions where the rate of acceleration depends upon the handling of the controller by the motorman. All information which can be obtained on these three points will be exceedingly valuable. The use of the track three miles in length will enable the cars to be run at speeds reaching 60 to 70 miles per hour as a maximum and making a schedule speed of 35 to 40 miles per hour.

TESTS OF MOTOR PERFORMANCE AND RISE IN TEMPERATURE.—In general, the performance of a car in service can best be represented by speed time and current curves. These show at once such items as rate of acceleration, maximum speed, rate of coasting and rate of braking. The power input to the car at any instant is shown by the line voltage and the current at that instant. The average power used by the car can be deduced by averaging the instantaneous power, and may be verified by a recording wattmeter. The schedule speed can also be deduced from the curve showing instantaneous speeds and can be verified by the time and distance. The power input when the car is running at any uniform speed gives at once the train resistance for that speed. From the current input to any motor of the equipment and the voltage at its terminals, the electric losses which take place in this motor can be readily found. These instantaneous losses averaged for the time of the entire cycle, give the average losses which determine the heat input.

By running the car backward and forwards, over a given track, repeating as nearly as possible each time, a given cycle of acceleration, maximum speed, coasting, braking and duration of stop, a condition similar to actual service is obtained. The temperature of the various parts of the various motors can then be measured at intervals until these temperatures become constant, which indicates that the heating effect of the current introduced into the motors is just balanced by the cooling effect due to the speed of the car. A time and temperature curve can then be plotted showing the rise in temperature of the motors during the run until they reach a constant temperature. Since the rise in temperature with given average losses in the motors will be largely influenced by the ventilation, which will depend largely upon the speed at which the cars run, the above operation should be carried out at several different schedule speeds with their corresponding cycles of acceleration, maximum speed, coasting, braking, and duration of stop. Such results will then show for the equipment under test the following:

(1) With a rise in temperature of 55° C. above the temperature of atmosphere what average losses (square root of mean square current and equivalent voltage) are permissible at schedule speeds of 25, 30, 35 and 40 miles per hour.

(2) With maximum average losses allowable in motors at schedule speed of 25 miles per hour (i. e. such as to give temperature rise of 55) what will be the rise in temperature with schedule speeds of 30, 35, and 40 miles per hour.

Such data will enable the probable performance of an equipment under a given service to be more closely estimated in advance than is now possible. In the above series of tests, the condition which we have in mind is one in which the car is kept constantly moving, with the exception of the comparatively short service stops, and with the exception of the time necessary to measure at intervals the temperature of the motors.

The condition on many interurban roads is such that a layover may be had at the end of each run. For instance, the car may layover half an hour at the end of a run of 2½ hours. A second series of tests in which the car is run in the same way with such a layover will show the effect of this layover on the ultimate temperature attained and will show the increase in average losses which may be allowed and still give the same ultimate temperature as was attained when the car was running without layover. It is evident that if no heat is added during the half hour layover, the consequent cooling of the motors will permit them to withstand greater average losses during the time they are running, than they could withstand if running continuously.

From a series of tests on one size of equipment, as suggested above, the performance of other sizes of equipment, can be estimated with a fair degree of accuracy; but if the equipment and time is available, we believe that it would be desirable to conduct tests as outlined in this report on cars equipped with both double and quadruple equipments of a total capacity of from 200 to 300 HP. However, we would recommend that a complete series of tests and curves illustrating them be made with one size of equipment, and the results of these tests analyzed, before making tests of other sizes of equipment, as it may be found that the average losses which the motors may safely withstand at different scheduled speeds do not vary sufficiently to make necessary further investigation on the subject.

TESTS OF TRAIN RESISTANCE.—Tests should be made to determine the train resistance with single cars and with different numbers of cars at various speeds from 40 miles per hour, upwards, as the train resistance at speeds lower than 40 miles per hour is fairly well understood. Train resistance should be measured in two ways: 1, by direct measurement of instantaneous power input when running at uniform speed, and, 2, by allowing the car or cars to coast and determining the rate of decrease of speed. The effect of different shapes of car front should be investigated if possible. The tests should be made if possible with one, two, three and four cars.

TESTS OF HAND AND AUTOMATIC CONTROL SYSTEMS.—When the object is to compare the relative economy of hand and automatic control, it will be sufficient to make tests of single cars. Where the object is to compare different systems of multiple control, more than one car should be used. The effect of the use of automatic acceleration on the power consumption and the general performance of a car can best be studied by plotting complete curves, showing the instantaneous values of speed, current, etc. Such curves should be plotted from tests on the same car, under conditions, similar, as nearly as possible, with the car equipped at one time with automatic acceleration and at another time without automatic acceleration.

A test should also be made to determine the saving of power, if any, made by using a mechanical device on hand controllers, to limit the rate at which the controller is thrown on. The data derived from such tests should show the average as well as the maximum power consumption at any instant during the cycle, and also the fluctuation of power during the cycle, when the resistance in the circuit is varied. From this data a comparison of the relative values of this type of control and unrestricted hand control may be made.

LOWERING THE CHICAGO RIVER TUNNELS has been reported on by Col. O. E. Ernst, U. S. Engineers. He recommends that the Washington St. and La Salle St. tunnels be lowered to give a depth of 26 ft. in the river, on the ground that such a depth would be required to carry 8,000 cu. ft. of water per second without making too rapid a current. This amount of water, it is figured, must ultimately flow through the river to the drainage canal. He finds that the city is owner of the tunnels and recommends that the order be directed to the city government; the time for completing the work to be limited to May 1, 1907, but the tunnels to be removed so that half of the channel shall be open to navigation by April 1, 1905. It will be necessary to abandon these tunnels at once and cofferdams will have to be built to the center of the river, enabling the contractor to build half of the new tunnel while leaving the other half of the stream free to navigation. The same recommendation as to depth is made in the case of both of these tunnels, though special emphasis is laid on the fact that at Washington St., where the river is narrow, the depth of 26 ft. is absolutely necessary. Regarding the Van Buren St. tunnel, Col. Ernst reports that no cofferdam work will be necessary and that reconstruction may be carried on without interfering with the use of the tunnel. The new tunnel will be completed before it will be necessary to remove the top of the old tunnel. This tunnel top is 18 ft. below the surface of the river, sufficient for navigation purposes, and until the new tunnel is completed there will not be any interference in the flow of the river for drainage canal purposes. The greatest depth actually required for navigation purposes is 22 ft.

NERNST AND COOPER-HEWITT LAMPS are a notable feature of the electrical equipment of the St. Louis Exhibition. The latter are shown as applied to general illumination, photography and photo-engraving work, and include some tubes or "lamps" 8 ft. long. There are about 10,000 Nernst glowers in use in the exhibition buildings, 6,000 of these being for the interior illumination of the Fine Arts Building, while the Westinghouse exhibit includes 300 large glowers for street use.

MACHINE FOR LOADING WHEELBARROWS OR CARS.

The practice of loading wheelbarrows, ore buggies, cars, etc., by hand shoveling is often followed in cases where the amount of work, or continuous work, would make it more economical to employ power machinery for the purpose. The accompanying views represent a machine designed especially for this class of work.

The machine consists of an inclined steel frame with a trough around it, in which trough travel the blades of a conveyor. At the lower end the trough is flattened out like a scoop and at the upper end there is a hole in the bottom, with a chute through which the material is discharged. The frame is 13 ft. long, 5 ft. 3 ins. wide, and can be tilted at varying angles, with a maximum height of 7 ft. for the discharge end. The weight is about 3 tons. It is mounted on a two-wheel truck with broad tired wheels (or flanged wheels if desired), and is driven by a 10-HP. electric motor; when the machine is to be moved forward or from place to place, the motor also serves to propel it by means of a link-belt gear to the axle. One of the wheels can be disconnected from the axle by a clutch, so that the machine can be swung easily to set it in any desired position. A lever handle at the side controls the scoop driving mechanism, and another throws the clutch of the propelling gear. The vertical screw in front is for regulating the inclination of the conveyor, and the long handle is for steering the machine when traveling. The trough in which the arms travel is 18 ins. wide, with a depth of 16 ins. at the inner side.

In operation, the machine is run up to the ore or coal pile, gravel bank, etc., so that the lower end or scoop of the conveyor trough will be fed by the material. The conveyor is then started, and the traveling arms carry the material to the upper end of the conveyor, whence it falls into the wheelbarrows or cars, or into an auxiliary portable belt conveyor to reach a greater elevation than that of the machine, as, for instance, in loading large railway cars. The arms travel at a speed of 60 to 80 ft. per minute, and the average capacity of the machine in handling loose material is about 90 cu. ft. per minute. The machine has been tried with success in loading ore from stock piles into the blast-furnace charging buggies at the South Works of the Illinois Steel Co., South Chicago, Ill. It has also been used in loading gravel, coal, stone, salt and other materials. It was designed and built by the Park Mfg. Co., Chicago, and we are indebted to that company for photographs and information.

Fig. 1. Receiving End.

Fig. 2. Discharging End.

MACHINE FOR LOADING WHEELBARROWS, ETC.
Park Mfg. Co., Chicago, Builders.

THE INFLUENCE OF SPECIFICATIONS ON COMMERCIAL PRODUCTS.*

By Dr. C. B. Dudley.†

We are so accustomed to regard the great mass of commercial products as completely in the hands of the producer, as something that the consumer is quite at liberty to take up or let alone as suits him, and as something in whose preparation he (the consumer) has had no voice, that the idea that the consumer does actually have an influence, or exert some force in giving shape and form or in deciding on the qualities which the article shall possess, does not seem evident at first sight. And yet we do not hesitate to reaffirm that the influence of the consumer appears in every successful commercial product, however great or however small, and that the consumer's power over the product, although perchance not appearing in formal and carefully prepared specifications, is nevertheless many times fully as great as, or even greater than, that of the producer.

Let us see if this can be made evident by an illustration. The commercial product in question is so simple an article as a pair of shoes. The producer or manufacturer has decided seemingly almost everything about them. He has determined the style, the shape and the size, the material in the uppers, the vamps and the soles, whether it should be button or lace, patent leather, French calf or cowhide, pegged or sewed, black or tan, and so on in infinite detail. And in each of these items he has not consulted the consumer, has had no specifications to work to, and apparently the consumer's voice in the matter has been nil; he can purchase the shoes or leave them as suits him best. The manufacturer has gone ahead and filled his warehouses, and perchance in his mind has figured up the profits on his year's work. But in all this, has, as a matter of fact, the consumer no voice? I trow yes, as many a manufacturer has found to his sorrow and loss who has too greatly ignored the power of the consumer in matters of this kind. If the shoemaker has used cowhide when the consumer wants French calf, his shoes are unsalable. If he has made a No. 6 size when the consumer's foot happens to be No. 9, there is a misfit and no business doing. If he has his whole product broad toes, when pointed toes are the style, and hence demanded by the consumer, his commercial product can hardly be said to be a successful one, and he will undoubtedly have to dispose of it as best he can, ofttimes at a loss.

But it may be urged, it is true, in staple articles of almost universal use the silent influence of the consumer on the product is granted. He would be a short-sighted producer who would attempt to ignore the demands expressed or understood, nay, even the foibles of the consumer, or what amounts to the same thing, would not study his market. But there are cases, such as the making of a new product for which a demand has yet to be created, where the influence of the producer on the product covers the whole field. The consumer does not yet understand the new product, does not know what kind of a material it should be, and has no voice in its production. Take for an illustration the new high-speed tool steel. The manufacturer decides everything in regard to this new product, independent of the consumer. He first learns how to make the steel, decides what its composition should be, learns how to treat it, practically changes all our ideas as to what heat will do to a piece of steel, and develops a new art of hardening and tempering, and after his qualities are finished, comes forth with his creation and teaches the consumer how to use it. Surely, it may be argued, in such a case as this the influence of the consumer on the product is not apparent. But those who so argue are fear, can have had very little experience in the birth and death of new things, many of them good; new things which might have had a long life of usefulness if the sponsors had not attempted to ignore the legitimate influence which the consumer has on even new commercial products, the fruit apparently of the brain energy of the producer alone.

The influence of the consumer on new commercial products is usually made manifest in the price he is willing to pay for it. If the new product is higher in price in proportion to results obtained than that which he is at present using, or if, even though economies are shown, he conceives the price is unreasonable, he will usually go on as he has been doing in the past, with the result that the new product fails to be successful. Makers of new things far too often make one or both of two serious mistakes. They either fail to sufficiently study the present condition of the field which their new product proposes to occupy, and as a consequence make the product cost so much to manufacture that it cannot successfully compete with what is already in the field, or having studied the field carefully and thoroughly, and having developed a new product which is a decided step forward over present practice and which produces notable economies, they place a price on their product such that the ultimate economy to the consumer is so small that there is no real reason why he should change. Not once, but scores of times, have we seen new commercial products fail from one of these two causes. The man who fails to study his field and makes his product cost too much should have our pity for his shortsightedness. The man who having devised and worked out something new which may be actually useful and valuable and who claims for himself all the financial advantage of the step forward, will find (if our observation and experience are worth anything) that he is killing the goose that may lay golden eggs for him, and that the disappointment which will inevitably follow his action is no more than a just punishment for his attempt to ignore the right of the consumer to a share in the advantage which comes from the progress of knowledge. This is hardly the time or the place to discuss this point to a conclusion, but we cannot help feeling that the legitimate sphere of the consumer is far too often almost completely ignored by those who are developing and exploiting new products. The point which we are trying to make is that always and everywhere, in every successful commercial product, both the producer and the consumer each have a legitimate sphere, and that any attempt on the part of either to ignore the other will result

*Annual Presidential Address before the American Society for Testing Materials, Atlantic City, N. J., June 16, 1904.

†Chemist, Pennsylvania R. R., Altoona, Pa.

is disappointment and failure. As we have tried to urge on other occasions, it is only by working together, by each respecting and honoring the rights and privileges of the other, that successful results can be obtained.

There is another view of this case which will perhaps bear a few moments consideration. A sound commercial transaction is one from which both sides secure advantage. A producer has something to sell from which he hopes to reap the reward of the successful business man. How shall he best accomplish this? Surely not as is too often the case, by trying to give the buyer or consumer that which he may happen to have in stock, whether it is fit or not, and trying to persuade him that it will be found all right, but on the other hand by trying to understand what the consumer really needs, and devoting his energies to furnishing that thing and nothing else. Or again, a consumer has a want and goes to a producer for something to meet that want. Shall the producer for the sake of the immediate transaction supply that which he knows will not give ultimate satisfaction? The temptation is certainly great, and the loopholes and possible explanations of failure are so many that it is to be feared in too many cases the transaction is accomplished without due regard to its effect on subsequent business. But I stoutly maintain that such procedure is shortsighted business policy, and that far too soon those who habitually do not give satisfaction will find their customers slipping away from them. In business parlance "they cannot hold their trade."

These business truisms would have no place in the theme which we are trying to discuss, except as they illustrate again the intimate relation between the interests of the producer and the consumer, and especially the influence which the consumer has on the successful commercial product.

Thus far we have considered the influence of the consumer which is (so to speak) not expressed. It is a silent influence, an unwritten specification, one real and tangible in its effects, but which has never attained to the dignity of being expressed in words or print. But our real theme is the influence of carefully worked out written or printed specifications, which are rigidly enforced, on commercial products. Perhaps we shall best bring out what we have in mind on this theme by dipping into the history of some of the forty or more specifications which have been prepared at Altoona during the past twenty-five years.

The history of the Lard Oil Specifications is an instructive one. When they were first prepared, now over twenty years ago, two grades of lard oil were in common use by railroads, known as "Prime" or "Extra," and "No. 1" lard oil. The former, which was the best oil that could be made from the materials, was largely used as the principal constituent of what is commonly known as signal oil, the oil which the conductors burn in their lanterns, and which was at that time used also in almost all signal lanterns everywhere. The function which this oil must perform is a very important one, since the safety of trains depends on the reliability of signals. The other grade, or "No. 1 Lard Oil," was and is practically used for lubrication. Both these oils when pure and of good quality gave excellent results in the places where they were used. The prices of both were high, the better grade often reaching a dollar a gallon, and the inferior grade from 70 to 80 cents per gallon. The better oil is light amber in color, while the poorer is inclined to red, and as the quality diminishes becomes more of a brown. The better oil is made from lard that is taken from freshly killed live hogs and is sweet and good enough to be used in cooking. The poorer oil is made from second or third grade lard, known in market as "No. 1 Grease" or "No. 2 Grease," and usually comes from hogs that have died in transit. All the animal fats, as is well known, are glycerides, that is, when they are in the animal (at least in good health) they are some characteristic fat-acid chemically combined with glycerine. But as soon as the animal dies from any cause, apparently decomposition sets in, one of the results of which is the separation of the fat acid from the glycerine. This separation is apparently also facilitated by the operation of rendering. Whatever the cause, the better grade of lard oil usually contains from one to four or five per cent. of free fat-acid, and the poorer grade may contain from ten to twenty-five per cent. of the same. The influence of this free fat-acid on the service of these two oils is deleterious. Careful experiments, many times repeated, show conclusively that a signal oil made from a prime lard oil containing the higher percentages of free fat-acid given above, will go out from crusting the wick much sooner, requires more frequent renewal of the wick and greater care, and is in every sense a less reliable oil, than one made from a lard oil containing less free fat-acid; while in the case of the poorer grade of lard oil, it is found that the more free acid it contains the poorer it is as a lubricant, and the more rapidly the journals and bearings disappear by wear. All this detail is necessary in order that what follows may be understood.

About a year or perhaps two or three years before the Lard Oil Specification was made a new product came forward, which has continued to the present day, which has added greatly to the wealth of the South, and which appears in more places in our modern civilization than many of us are aware of. The oil referred to is made from the seeds of the cotton plant, and is commonly known as Cottonseed Oil. This oil is a beautiful bright, clean, almost odorless material, containing very small amounts of free fat-acid, but unfortunately is in its properties on the border ground between the drying and the non-drying oils, having some of the characteristics of both. It is not enough of a drying oil to be used successfully in paints, and on the other hand is too much of a drying oil to be used successfully either for burning or lubrication. It crusts the wicks and the light goes out in four or five hours, and it gums so badly as to be almost useless for lubrication. The price at the time of which we are writing was fifty cents a gallon. What now could be more natural than that this oil in some way should find its way into the lard oils which have been described above. It diminished the free fat-acid of both grades, and especially improved the appearance and apparent salability of the poorer grade, to say nothing of the delicious rakeoff of from twenty to fifty cents for every gallon of it used in the mixtures.

That it was being so used was suspected by consumers for some little time before the Lard Oil Specification was prepared, but it was only a suspicion. The chemistry of oils was at that time so poorly understood that no one could prove it. The use of the oils in service indicated it, but that was all. A couple of weeks rather hard study in our laboratory developed a test which about a year later was independently developed by another observer and published, which made it possible to say with rather remarkable certainty whether a sample of lard oil was pure or not. It was not always possible to say what the admixture, if any, was, but if cottonseed oil was present the amount could be told to within one per cent. Also a method of determining free fat-acid in oils was developed. Armed with these two tests, the oils of the market were questioned. At first small samples were obtained and examined before orders were placed, it being required simply that shipments should be like sample. The first month's samples numbered thirteen, and only three were found to be pure and of the proper quality. The next month's samples were seventeen, of which seven were satisfactory. In the course of a few months, or as soon as the trade became convinced that only those who furnished samples which were free from admixture of other oils and were satisfactory in other respects would get orders, all the monthly samples would pass the necessary tests, except that occasionally a new party would be asked for samples, in which case it usually took two or three months to convince him that nothing but straight goods would pass muster.

But now a new difficulty arose. The samples would be all right, but the shipments or deliveries would be all wrong. Not a few contests were characteristic of those days, which contests were marked on the part of the producer by wordy assertions, by appeals to business reputation and standing, and by threats of litigation, and on the part of those in charge of the purchase and use of the goods, by a quiet determination to defend to the death the interests committed to their care. Not yet in this particular industry had the producer learned that there were limits to his power over his own product, and that the consumer had rights which even he, the maker and owner, must not ignore. Fortunately, notwithstanding the bluster, the strife was confined largely to words, and after the affray (which lasted a year or more) was over it was found that the conflict had resulted so far as the producer was concerned in some loss of business, in some financial loss due to paying return freight charges on rejected shipments and in traveling expenses to Altoona for the word combats above referred to, and also in a serious loss of business reputation. It is perhaps not too much to say that as a matter of fact within a year or year and a half after this contest began not a few of those who for years had furnished lard oil were stricken off the Purchasing Agents' lists, and to this day have not succeeded in reinstating themselves. On the part of the consumer the results of the contest were gratifying. Improvement in the service immediately followed and bills were paid with the knowledge that a full, honest equivalent was furnished for the money spent. The information accumulated during these few months of contest was ultimately embodied in specifications, and for many years now, although safely hundreds, perhaps thousands, of shipments have been tested, there has been scarcely a rejection for failure to meet requirements. Perhaps more important than all, a beginning had been made toward the establishment of a principle: that the influence and rights of the consumer in any commercial product if it hopes to be successful can never be ignored or lightly set aside. The special teaching which we would draw from this episode as applicable to our theme is that enforced specifications protect the honest dealer from unfair competition. The concomitant protection against purchasing an inferior product at the price of a better one, and against using inferior materials in most important service which they give the consumer, will not escape notice.

Perhaps some additional side light on our theme may be thrown by the history of another Altoona specification. It is now perhaps twenty-five years ago that a certain special car happened to fall under the eye of one of the officers responsible for the maintenance of equipment who observed that the varnish on the outside seemed to have perished almost completely, and that the integrity of the painting underneath was in consequence seriously threatened. The car was sent to the paint shop for special examination. The shop reported that the car had been varnished at so recent a date that ordinary wear would not warrant its present condition, and that the loss of varnish was probably due to excess of zeal on the part of the car cleaners. The matter was referred to the foreman of the car cleaners, who reported that they had given the car a pretty good treatment, but that really they could not be held responsible for any better results with the soap that was furnished to them. In order not to be set aside and diverted from his efforts to secure efficiency, by the customary attempt on the part of subordinates who are called to account to transfer the blame to some one else, the officer above referred to asked for a sample of the very soap used, and a partly used cake was furnished and sent to the laboratory.

Now, ordinary cleaning soap, as is well known, is a chemical compound of the various acids characteristic of vegetable or animal fats, with either soda or potash or both. The combination is brought about by the aid of heat, the fats being mixed with the soda or potash in water solution, and the resulting product always containing more or less water as a necessary concommitant of the manufacture. Potash, being more expensive than soda, is less often used. But soda soaps are softer than potash soaps, and, as is well known, the physical condition of a soap as to hardness is an important element in its successful use. Moreover, the nature of the fats used has a most important influence on the hardness of the soap. The soft animal fats whose characteristic fat-acid is undoubtedly largely oleic, when saponified with soda, gives a soft mushy soap which is uneconomical to use, is less easy to handle both in manufacture and transportation, and is often unsalable in appearance. These objectionable characteristics are largely increased by the practice, so common among soap makers, of adding a percentage of rosin to the fat. Tallow, which contains a considerable percentage of stearic acid, makes a much better soap. But tallow is more expensive than the soft fats and rosin. Accordingly, soap makers have sought for devices that would harden soaps made from the soft fats and rosin, and it has been found that an excess of alkali, and especially a percentage of carbonate of soda added toward the last and thoroughly mixed with the soap before it cools and hardens produces the result desired.

Returning now to the partly used cake of soap. A careful analysis of this sample showed that it contained, in addition to the alkali necessary to combine with the fat, about 3½% of free caustic soda, and over 7% of carbonate of soda. It will thus be seen that the water solution of this soap which the men were using to clean the cars with was in reality a weak lye, containing quite an amount of sodium carbonate. But both lye and carbonate of soda in solution readily dissolve varnish; even the combined alkali of a normal soap dissolves varnish to a certain extent, but very much more slowly than the free caustic or carbonated alkali, even though the latter may be in very dilute solution. It is evident that the contention of the men in this case had a foundation of fact, and while it is recognized that the manipulation, that is, the method of using the soap solution, is a most important element in the problem, it is unquestioned that in the hands of the ordinary car cleaner, such a soap as has been described will result in a much more rapid destruction of the varnish than if a normal soap was used. This incident led to the formation of specifications for soap in which the amounts of free caustic and carbonated alkali were limited, and no similar case of very rapid varnish deterioration has since been noticed.

Now this case has not been cited to show that the producer had any desire to ignore or set aside any of the rights or even desires of the consumer, or to obtain for himself any undue, ulterior advantage at the expense of the consumer. In reality the producer was furnishing more detergent power per pound of soap than is characteristic of the normal article, since both free caustic and carbonated alkali are much stronger in detergent power per pound than the combined alkali of soaps. There is apparently no reasonable ground for an attempt to hold the soap maker responsible for the injury to the varnish, and we cannot help regarding this episode as illustrating "The Influence of Specifications on Commercial Products," in this: that they tell the producer what the consumer wants. It is not to be supposed that the producer will know all the uses to which the consumer will apply his product, and without co-operation on the part of the latter, or as we have so many times urged, without the two working together, the producer may with perfect honesty make and furnish the wrong product.

One more illustration of the stimulating effect of the consumer on commercial products, and I have finished. It was for a long time customary to use only crucible steel in making springs, either helical, elliptic or semi-elliptic, and in these springs the carbon employed was usually from 0.65% to 0.75%. The service of these springs was very unsatisfactory. The breakage was something appalling, such that at some of the important repair shops a car load of broken helical springs would accumulate in a few months. At that time the spring makers decided on both the kind of steel to use and the design. They were given the space that could be allowed for the spring, and the load it must carry, and they did the rest. In fairness, it

should be stated that the conditions were severe, and that apparently neither producer nor consumer understood the situation. Very few tests had ever been made, and apparently the strains in the metal had never been calculated. The matter was taken up with some vigor by the consumers' experts and an attempt made to get an understanding of the situation. It developed that when some of the helical springs then in use were brought down solid the strain in the outside row of fibers was over 110,000 lbs. per sq. in. What wonder that the springs broke. As a result of the study of the matter, a specification was prepared covering both the design and the quality of steel to be used. In view of the small space available, and with the tendency toward increasing loads already mentioned, it was felt that every advantage must be taken, and accordingly a round bar was decided on as being best able to resist the strains, instead of the flat or oval which had previously been used; the maximum fiber stress was placed at 80,000 lbs. per sq. in. instead of the indefinite 110,000 lbs. or more which had been characteristic of previous practice; and also 1.0% carbon steel was specified instead of 0.70%, as had previously been used; still further, no mention was made of the process by which the steel should be made.

This proposed specification likewise met with some antagonism. It was urged, not without a good deal of show of reason, that crucible steel was the only fit material to use in making springs, and that so hard a steel as is given by 1.0% of carbon would be unreliable and probably cause more difficulty than had heretofore been experienced. It should perhaps be added for information that at this time the possibility of making a high carbon steel in the open-hearth furnace had not been fully demonstrated, and that this proposed spring specification, leaving out the process by which the steel should be made, was a direct stimulus in the development of this method. The crucible steel people were therefore naturally a little anxious. It is undoubtedly well known that at the present time by far the largest portion of the steel used in springs is made in the open-hearth furnace. Notwithstanding the antagonism, the specification as drawn was sent out, and although there were some difficulties at the start, and at least one spring maker refused to fill orders, it soon became evident that the specification was going to survive. The results in service were most gratifying. When 30,000 helical springs according to specifications had been put in service a count was made of those which had broken and only two were found. After three or four years, when there were perhaps two or three hundred thousand of these springs in service, a request was sent to one of the principal repair shops to send twenty broken springs to the laboratory, in order that the relation between phosphorus and broken springs might be studied. At the end of three months only twelve had been secured, and these were used as the basis of the investigation.

The effect of the specification on the producer was equally satisfactory. Special and patented forms of bars absolutely disappeared, the open-hearth steel makers soon learned how to make with perfect success a high carbon steel, and from being antagonistic the spring makers soon changed to the warmest friends of the specification, and recommended it everywhere to other railroads. It is perhaps not too much to say that 95% of all the freight cars built in the United States within the last twenty years are fitted with helical springs closely patterned after or made in accordance with the specifications whose birth we have been trying to describe.

It would be easy to continue this discussion to almost any length, but I spare you. Nearly every one of our forty or more specifications at Altoona has a more or less interesting history, and some of them would illustrate points in our theme which we have not been able to bring out. But I fear this paper is already too long, and that I have wearied your patience. The conclusions from the episodes given and from the incidents recounted have perhaps been made sufficiently clear as we have gone along in our discourse. But I am sure you will bear with me while I give you one general conclusion which, to our minds, sums up the whole matter: The influence and voice of the consumer in the manufacture of commercial products have come to stay, and it is simply the part of wisdom for all concerned to recognize the situation. Also since both the producer and consumer have each a direct interest in the product or thing made, the one in its production and sale, and the other in its use, there is no real reason why each should not study the product in most minute detail. If the producer knows better than the consumer, as he undoubtedly does, the effect of composition and details of manufacture on the thing made, so also does the consumer (if he studies as he should the behavior of materials in service) know better than the producer knows or can know the relation between the composition, the physical properties, or even minute characteristics of the thing made and its successful use. It is only by the combination of information from each of these two sources that perfectly successful commercial products can be obtained. Finally, if these views are accepted as correct, is it not evident that all energy spent in antagonizing each other is so much lost effort, and that the true policy is to work harmoniously together in our attempt to convert the crude materials of nature into a shape to be useful in the service of man?

THE USE OF HOISTING ENGINES FOR LOADING WHEELED SCRAPERS ON THE GOULBURN-WARANGO WATER-WORKS, VICTORIA, AUSTRALIA.

By G. H. Dunlop, M. C. E.*

Upwards of 20 years ago the Government of this State initiated a scheme of works for water supply, to consist ultimately of a weir on the Goulburn River near Murchison, eastern and western main channels therefrom, a large reservoir at Waranga to be filled from the western channel, and works for distributing the water northward towards the Murray River. The weir and part of the main western channel were constructed about that time, and the further execution of the scheme has lately been resumed. Contracts have been let for the completion of the western channel to the reservoir, for the reservoir embankment, etc., and for the first section of the main outlet channel.

The outlet channel will be a cutting 40 ft. wide at the bottom, with 1 to 1 side slopes, varying in depth from 0 to 42 ft., mostly in clay, but partly in rock. The spoil is placed alongside of the cutting, leaving a berm 30 ft. wide. The material, so far, has been removed by American wheeled scrapers of about 16 cu. ft. capacity, drawn by two horses. The contractors for the outlet channel, Messrs. Reilly Bros., use an ordinary winding engine, instead of an extra team, for loading the scrapers. The engine is placed on the bank, close to the edge of the cutting, with suitable leading blocks so that the hauling rope may pass either way about 300 to 400 ft. along the channel. A ⅝-in. steel wire rope is used, which is attached and detached at the pole of the scraper by an attendant. A pony with light harness, ridden by a small boy, drags the wire rope from place to place for this attendant.

Messrs. McClelland & Cooper, contractors for part of the inlet channel, afterwards adopted this system for filling wheeled scrapers. They placed the engine in their cutting, which has a bottom width of 117 ft., and is not deep. (They used five-horse drag scrapers also.)

The employment of winding engines for loading is deemed highly successful by the contractors who have used them. The horses soon learn to leave all the work of loading to the engine, and so are fresher for the work of conveying; the rope can be attached and detached very quickly, and there is ample power for loading.

The scrapers bear the strain of loading in this way fairly well, but appear to be of rather light construction for such work. Messrs. Reilly used a special mechanism, invented by Mr. Phillip Reilly, for regulating the depth of cut when loading the scraper, which acted very efficiently. Messrs. McClelland & Cooper used a gage wheel under the rear end of the pole to prevent the scraper from cutting too deeply into the ground, and to prevent undue pressure on the necks of the horses. With the former appliance the bottom of the scraper seemed to be held more nearly level, so that the strain at the cutting edge and bottom of the scraper was less.

It seemed to the writer that on work of sufficient magnitude the use of the winding engine would probably effect a saving of 2 cts. per cu. yd.

At time of writing the Messrs. Reilly had not excavated in the deeper parts of their cutting to more than one-half of the depth, and were intending to use the wheeled scrapers for the other half also. They would remove the pole, put a third wheel at the front, load with the engine, and haul up the 1 to 1 slope by horses, traveling on the bank, using a long rope and pulleys and a derrick pole.

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ANNUAL CONVENTION OF THE BRITISH ASSOCIATION OF WATER-WORKS ENGINEERS.

(Editorial Correspondence.)

Compared with our water-works associations in America, the British Association of Water-Works Engineers is quite young and its membership is small. Nevertheless, it is doing good work, as its published volumes of proceedings attest and as was indicated by its ninth annual convention, held at Hull, June 9 to 11.

Entering the town hall and passing up the stairway to the council chamber, in which the sessions of the convention were held, the [illegible] the city is impressed upon one by reading, [illegible] with a statue of Edward I., an extract from [illegible] charter granted to the borough by that king [illegible] 1299. The council chamber is a large room, [illegible] suited to its purpose, with mural paintings [illegible] relating to the history of Hull.

When the time for opening the convention arrived the chairman announced that [illegible] mayor was in waiting and requested quiet. In America, city officials who are to welcome conventions generally wait in the meeting hall for the [illegible] members to present themselves, or else come [illegible] in out of breath, say their say, and rush [illegible] again. Not so in England. The mayor and the sheriff, decorated with elaborate gold chains [illegible] ornaments, come in from an adjoining room [illegible] after the former had addressed the convention, both remained through a goodly part of the session. At the mayor's luncheon, given soon after in the large banqueting room of the town hall, both these officials appeared in the regalia of their office with attendants in livery.

Four sessions were held for the presentation of nine papers, or ten, including the inaugural address of the president. The luncheon mentioned came on the first day. In the evening of the same day there was a smoking concert, provided by the president of the association. In the evening of the second day the annual dinner was held and the morning of the third day was used for a drive to the pumping stations. Both the dinner and the drive were at the expense of the several individuals in attendance.

THE PRESIDENT'S INAUGURAL ADDRESS.

It appears to be the custom of the association to hold its annual conventions at the home city of its incoming president. Accordingly, the chair at this meeting was occupied by Mr. Francis J. Bancroft, Assoc. M. Inst. C. E., Water and Gas Engineer to the municipal corporation of Hull.

Speaking first of the membership, Mr. Bancroft said that it now numbers exactly 300, of which 2 are honorary, 197 full and 101 associate members. This is an increase of 14 over the year 1903, and of 38 over 1902. Estimates indicate that the members are responsible for the management of works involving a capital cost of $270,000,000, serving a population of 14,000,000 with a daily supply of 533,000,000 U. S. gallons.

The committee on the standardization of cast-iron pipe had referred the work entrusted to it to the Engineering Standards Committee, which had appointed a sub-committee on that subject and placed upon it three members of the council of the association.

Mr. Griffith declared that he was no believer in the small per capita consumptions reported from towns which are really short of water, or liable to be every dry season. And yet, it would surprise some laymen in America to learn, he proposed as a standard for a *maximum* daily supply for large cities, in the near future, 60 U. S. gallons per capita, and for small towns and rural districts a maximum of 43 U. S. gallons. An allowance of 20% above the average was the basis suggested for the maximum supply. In Hull the maximum daily consumption in 1893 was 122% of the average, and the maximum hourly demand "under ordinary circumstances" is 170% of the average demand for that day, thus making the demand for the maximum hour twice that for the average hour.

The population of Hull increased from 91,000 in 1853 to 254,000 in 1893; the average daily consumption from 30 to 43.2 U. S. gallons; while the maximum daily demand decreased from 54 to 51.6 U. S. gallons. Both the average and the maximum consumption rose and then fell within the period, the average reaching 51.6 and the maximum 64.8 U. S. gallons in 1893. A marked rise in the average followed the change from an intermittent to a constant supply in February, 1871.

The water supply of Hull is drawn from the chalk, and a considerable portion of Mr. Bancroft's address was devoted to the available yield from that source and the liability of wells to pollution. To guard against this danger another municipal corporation (Portsmouth) has built a puddled clay wall, carried 12 to 30 ft. below the surface, around the seven acres of land in which its springs are located.

Mr. Bancroft advocated the laying of trunk mains in large cities, near the curb and the placing of the service mains beneath the sidewalk, one on either side of the street.

A department of the Local Government Board, devoted wholly to water supply, was also advocated by Mr. Bancroft. Every public water supply should be subjected to an annual inspection by the central government for the better protection of the quality of the water. A revision of the statutes relating to water supply is needed, there having been no general legislation on the subject since 1847, all subsequent acts being amendments to the one passed that year. Annual returns to a central authority should be required from each water-works in the country, similar to those for gas works now made to the Board of Trade.

WORKING COSTS OF WATER-WORKS PUMPING ENGINES.

A lengthy paper on this subject was presented by Messrs. A. H Meysey-Thompson and H. Lupton. As a unit or standard of comparison the authors took

> the cost of one horse-power maintained day and night continuously for one year, such horse-power being neither nominal nor indicated, but an actual 33,000 ft.-lbs. of work measured in water raised per minute throughout the year.

The paper contained many figures, based on pumps connected with various water-works, but the costs being in pounds, shillings and pence, the quantities of water in Imperial gallons, and the duties in foot-pounds per 112 lbs. of coal, the figures as a whole are not directly comparable with American figures. In general, the cost of pumping was shown to decrease with the number of horse-power of the plant.

In the course of the discussion several speakers gave it as their opinion that aside from main features the design of pumping engines might best be left to the manufacturers. One speaker advocated the use of low-grade coals, but others, chiefly remote from the coal-producing centers, spoke as strongly in favor of high-grade coal. It appeared from the paper and the discussion that both gas and oil pumping engines are common in England, but mostly for small plants, of which there are many. One speaker objected to crude oil for oil engines because of the labor involved in cleaning, but another stated that he used crude oil for a 42-HP. engine and could run the engine 23¾ hours out of the 24.

PUDDLE AND CONCRETE FOR RESERVOIR EMBANKMENTS.

A comprehensive paper on this subject, evidently based on a professional experience of many years, was presented by Mr. Wm. Watts, Assoc. M. Inst. C. E. An abstract of this paper will be given in a future issue.

In the course of the discussion on this paper a speaker stated that judging from his experience life would hardly be worth living without office tests of cement. The very simple boiling test alone is of great value. The neat tensile test, however, is of no earthly use. The Germans have dropped it, and the English should do so.

Mr. Anderson thought that each kind of stone to be used for concrete should be tested before deciding not to wash it.

Mr. C. Clemasha Smith, Assoc. M. Inst. C. E., Water-Works Engineer of Wakefield, said that he preferred puddle to concrete where tenacious material can be obtained. Puddle is more elastic, more easily inspected, and, because of the greater width of the wall, less likely to allow water to pass. Workmen always have a strong tendency to favor the contractor under whom they are working, and may get in poor concrete clear across the trench and thus make a weak spot in a wall.

Mr. R. E. Middleton, M. Inst. C. E., did not see why puddle walls needed to be any thicker than those made of concrete. As to concrete, his own experience was that it would crack at intervals of about 30 ft. In the case of the concrete aqueduct connected with the Staines reservoirs of the London water companies, expansion joints of brick had been inserted 30 ft. apart. In a length of nine miles the loss in the aqueduct is only 180,000 U. S. gallons a day, all of which may not be due to leakage. Good results in the way of water tightness may be obtained by applying a thin layer of much richer concrete to the water side of structure.

In closing the discussion, Mr. Watts said that good concrete could be secured by proper inspection of the mixing and laying. As to cracks in concrete, he now had two long heart-walls under construction which showed no cracks. Narrow trenches for puddle give altogether too narrow a margin of safety.

THE ADMINISTRATION AND CONTROL OF THE NATION'S WATER SUPPLY.

Mr. R. E. Middleton, M. Inst. C. E., the author of this paper, proposed that each great drainage area of the country be placed under the control of a sepaate body "for purposes of the conservation of the water supply, preservation of fisheries the prevention of pollution and the disposal of sewage." These authorities would be responsible to a central authority, created for the purpose, which in turn should hold the several boards to the enforcement of the laws for the prevention of pollution. The drainage area boards would be authorized to divide the areas under their control into districts, and where such districts failed to carry out needed sanitary works the drainage area boards would have authority to make the necessary improvements at the expense of the districts. The author continued:

> Another important duty might be very properly placed upon the new authorities, viz., the collection, verification and tabulation of rainfall and other meteorological statistics, the gagings of rivers and streams, the measurement of varying water levels in wells, the provision of statistics of water supplied, capacity of reservoirs, etc., and level or water in same, and other data bearing upon questions of public health. In this connection it might be necessary that powers should be given to compel private owners to give facilities for obtaining the requisite information, but in any case water authorities and companies should be put under obligation to measure the quantity of water they receive and supply, and to afford all information with regard to reservoirs and wells.
>
> The information thus obtained should be submitted periodically to the Central Department, by whom it should be tabulated and published within a reasonable time. It would, further, be of great value if maps could be prepared showing the location and extent of the underground drainage areas as well as those above ground. In a similar manner, statistics having reference to the treatment, purification and disposal of sewage should be collected and published.

Suggestions for drainage area or water boards, subject to a central authority, have been made by a number of Royal Commissions on Sewage Disposal, including the present one, and also by the author of the present paper, in 1897, 1898 and 1903.

Mr. Jones, in opening the discussion, said that the Local Government Board now has control of local authorities generally and the Board of Trade controls private corporations. He favored an independent body to control public water supplies. Other speakers also endorsed the general position taken by the author of the paper in regard to a central authority. This position, it was stated by Mr. Percy Griffith, accords with that held by the association for a number of years.

Mr. M. N. Baker, of the editorial staff of Engineering News, briefly reviewed the attempts to preserve the purity of public water supplies in the United States, as entrusted to the State Boards of Health of Massachusetts, New York, Ohio and Minnesota and the State Sewerage Commission of New Jersey. In closing the discussion, Mr. Middleton said that the Massachusetts State Board of Health had done a large amount of valuable work at a relatively small expense.

EFFICIENCY TRIALS OF AIR-LIFT PUMPING PLANT FOR THE CORPORATION OF BIRKENHEAD.

This paper was presented by Mr. J. W. Richardson, Assoc. M. Inst. C. E., Engineer of the water-works in question. The air-lift was installed in 1901. The well is 800 ft. deep, 31 ins. in diameter for a distance of 150 ft. below the surface, and 24 ins. for the remaining depth. When it was decided to put in the air-lift there was already in place, for purposes of testing, an ordinary deep well pump at a depth of 190 ft. below the surface and capable of pumping about 600,000 U. S. gallons a day. The short time in which the air-lift could be installed and the possibility of using the old pump meanwhile were the principle factors in leading Mr. Richardson's predecessor to recommend that system as a permanent method of pumping. The air-lift delivers water to a tank at the surface, from which it is repumped by Blake-Knowles pumps to a tank and reservoir some 200 ft. higher. The paper included descriptions and tests of both the air-lift and the steam pumps.

The contract was awarded to F. A. Craig & Co., of Paisley, Scotland. The contract guarantee for the air-lift called for a duty at 48 revs. per min. and 54,000 U. S. gallons per hour pumped from a depth of 780 ft. below the surface of not less than 63,000,000 ft.-lbs. per 112 lbs. of Nixon's steam navigation coal, assuming that the city supply 9 lbs. of dry steam per pound of fuel burned, and that the water in the well is 300 ft. below the surface. With other water levels the duties were to be as follows: At 160 ft., 39,000,000 ft.-lbs.; at 200 ft., 45,000,000 ft.-lbs.; at 240 ft., 54,000,000 ft.-lbs.

The rising water pipe placed in the well was 9⅜ ins. in diameter and the air pipe was 3 ins. in diameter. Under ordinary conditions the water in the well is 198 ft. below the center of the air-lift discharge.

Three sets of tests were made, and these were reported in detail in the paper, but the figures are too numerous to present here. It must suffice to say that after calling in Prof. H. S. Hele-Shaw, of University College, Liverpool, as referee, to carry out the third set of tests the plant was accepted by the city.

For the 17 months ending Jan. 31, 1904, the actual cost of operating both the air-lift and the steam pumps under a combined head of 350 ft., and lifting a total of 380,000,000 U. S. gallons, was at the rate of 2.52 per 1,000 Imp. gallons actual lift, or 0.72 pence for a lift of 100 ft. This is about $12 per 1,000,000 U. S. gallons lifted 100 ft.

No little criticism was heaped upon both the diversity of the results obtained in the three tests presented in the paper and upon the economy, or lack of economy, of the air-lift, but the author subsequently pointed out that his object was not to advocate the air-lift or to defend the tests, but merely to present such data as were available. In general, the various participants in the discussion agreed that the air-lift was a convenient rather than a mechanically efficient apparatus, but some defense was made of it as a substitute for deep well pumps, wear and tear being considered. Mr. Dewhurst stated that in a small air-lift plant connected with his works the water tube was expanded in size towards and at the top, with the idea of reducing the friction due to the expansion of the rising air. The air pipe was placed outside the water pipe so as not to contract the cross-sectional area of the latter. Mr. Black said that, judging from many air-lift plants with which he had been connected, the air-lift was of value, particularly where the air pipe extends nearly to the bottom, in keeping the bottom of the well open to the incoming water.

THE PRACTICAL DEFINITION OF "PURE AND WHOLESOME WATER" AND "POLLUTION."

This paper was read by Dr. John C. Thrash,* F. I. C. After dwelling upon the diversities of opinion as to what constitutes pure and wholesome water, the author laid down the following definitions:

> A pure water is one which is bright, odorless, and free from obvious color, contains but the merest trace of organic matter and no mineral constituents objectionable either on account of their quality or quantity, and which is free from organisms derived from sewage or manure.
>
> A wholesome water may be a pure water or a water containing only such impurities as would have no effect upon the health of persons drinking it.
>
> An impure water is one which contains either objectionable mineral constituents, or mineral constituents in excessive amounts, or more than a minute trace of organic matter, or organic matter of an objectionable type.
>
> A polluted water is an impure water containing traces of sewage or similar contaminating matter of a possibly disease-producing character.

The fact that millions of people have used water from the Thames and Lea for years "without the slightest proof being adduced of its having prejudicially affected their health" weighs infinitely more than any theory as to the wholesome character of the water supply of London.

Towards the end of his paper Dr. Thrash urged that chemists and bacteriologists "extend their studies beyond the limits of their laboratories, and take into account the evidences of practical experience." The first part of this suggestion may be interpreted as meaning that inspection for actual sources of pollution should be an accompaniment of analyses. As for the presence of *B. coli* in water as an evidence of sewage contamination, the author thought that it alone need not condemn a water, since, if sewage had gained access

*Lecturer on Public Health, London Hospital Medical College, London, England.

to the water other organisms associated with sewage would also be present and capable of detection.

In discussing this paper, Dr. Wilson inquired whether the time had not arrived when samples of water submitted for analysis should no longer be regarded as puzzles. As to B. coli, he would condemn any water containing large numbers of that organism. Mr. R. E. Middleton said he believed that with good filtration the dangers from surface water supplies were infinitesimal. Mr. Percy Griffith commented on the frequent disagreements between analysts when reporting on samples of water from the same sources. He thought that when analysts and medical officers of health come to an agreement on what constituted wholesome water engineers would gladly follow suit.

THE TREATMENT OF MOORLAND WATER.

Under this title Mr. C. Clemesha Smith, Assoc. M. Inst. C. E., Engineer of the Wakefield Water-Works, described a series of experiments on the treatment of water to prevent lead poisoning. An abstract of the paper appears elsewhere in this issue. Owing to lack of time there was no discussion on this paper.

EXTENSIONS OF THE WARRINGTON WATER-WORKS.

This paper, which was read by title, only, was prepared by Mr. George Mitchell.* The first improvement described was the construction of slow sand filters, to clarify the water for trade purposes only. The filtering material consisted of 24 ins. of sand, supported on gravel having an average depth of 10 ins., resting on a false bottom of perforated tiles, supported, in turn, by brick laid flatwise. This form of drainage has been used elsewhere for some 30 years.

The awkward, and as the author himself says, expensive method of preparing the sand and gravel used in the filters is described in the paper as follows:

> The sand was obtained locally, and many experiments were made in order to see if anything like uniformity of grain could be obtained at a reasonable cost. No very satisfactory result was obtained, however, and finally the sand was treated as follows: It was first screened to remove the fine gravel, and was then washed in a sand-washer, of the type in which water under pressure is fed below a perforated plate whereon the dirty sand lies, the mud being carried to waste by the overflow of the water. The sand was vigorously stirred during washing, and after the water had been run off, the finest of the sand was skimmed off with shovels and thrown to waste, that remaining being then washed in long troughs having a current of water constantly flowing in them, the sand being shovelled in small quantities into riddles held under water and vigorously shaken. Most of the sand passed through the riddles into the troughs, and the finest was again skimmed off and thrown to waste. The sand remaining on the riddles formed about 2 ins. in depth of coarse sand on the filters, which acted as a supporting medium for the 22 ins. of finer sand above. The above method produced very satisfactory clean sand, but the cost to the contractors was very great. The gravel was washed in troughs similarly to the sand, and was of three grades, the lowest being less than 2 ins. diameter, but retained on a 1-in. riddle; the middle passing a 1-in., but retained on a ⅝-in. riddle; and the upper passing a ⅝-in., but retained on a 3-16-in. riddle.

*Assistant Engineer in charge of water-works extensions, Warrington, England.

A new covered pure water reservoir, with a diameter at one flow line of 107 ft. and a capacity of about 820,000 gallons, was erected. It was built almost entirely of concrete, but the piers supporting the roof were of brick and the roof itself was of steel-concrete. Although the concrete was made with Portland cement it was considered necessary to take special precautions to make it watertight. Accordingly, a material known as "Callender's bitumen sheeting" was used, and to avoid the heavy expense of the usual protective covering to the sheeting is was decided to place the latter at the back of the wall, instead of inside of it. The method employed was as follows:

> On the concrete foundation for the walls bitumen sheeting was laid of a width sufficient to leave a considerable lap at both sides, and, the walls having been built, the sheeting was continued up the back, being tied into the walls by small bolts with 6-in. cast-iron washers, placed about 30 ins. c. to c., horizontally and vertically. These bolts were for the purpose of keeping the sheeting in place, and to prevent it from bagging should any pressure be caused by water getting between the wall and the sheeting; 6 ins. of fine wet clay was filled in behind the sheeting, and care was taken to keep all large stuff well away from it. When the walls were complete the [illegible] was put in as follows, viz: 4 ins. of concrete below [illegible] ins. of concrete above the sheeting, finished with [illegible] ing laid to fall 4 ins. toward the wash-out [illegible] inside face of the walls was not rendered. [illegible] The was taken by soaping the cleading that a [illegible] care produced on the concrete, and after the wa[illegible] was they were well cleaned down, washed [illegible] built brushed over with thin cement grout.

Cast-iron pillars, the author consi[illegible] form the ideal support for reservoir roofs "w[illegible] thoroughly good work can be secured," bu[illegible] ing to difficulties previously encountered in g[illegible] iron blue brick piers were used for this reser[illegible] These were only "1½ bricks square," and "v[illegible] ing in proportion to their sectional area," so [illegible] great-est care was taken in selecting the ma[illegible] and in levelling and plumbing the work at [illegible] fre-quent intervals." One result of this [illegible] was labor charges six times as high as th[illegible] for ordinary brickwork.

The roof consisted of 4:1 concrete, 4½ [illegible] thick in which was embedded No. 8 expa[illegible] steel, the whole being supported on "rolled st[illegible] joists," 7⅞ ft. c. to c. The piers, on the line of the joists, were at a maximum distance of 15⅓ ft. c. to c.

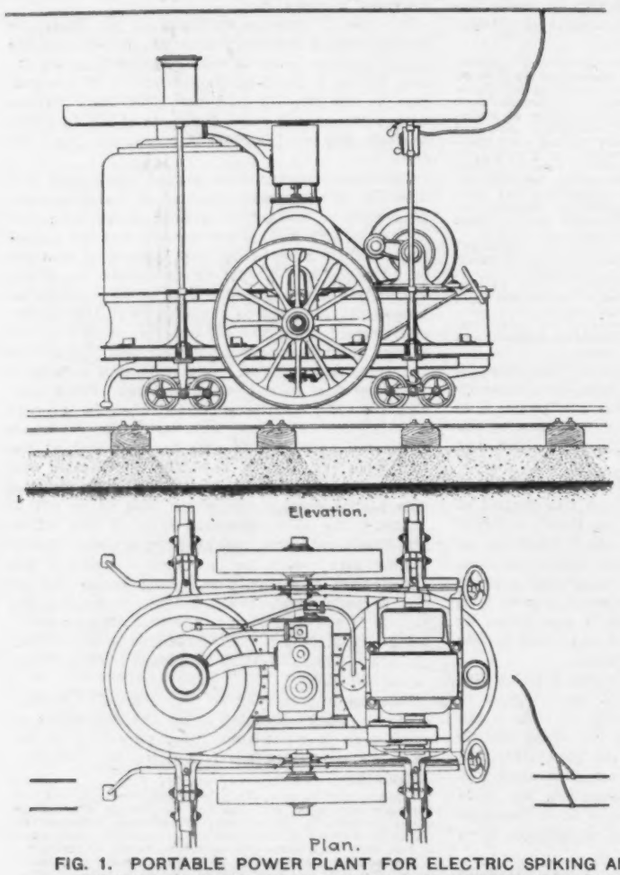


FIG. 1. PORTABLE POWER PLANT FOR ELECTRIC SPIKING AND TAMPING MACHINE; PARIS, LYONS & MEDITERRANEAN RY.
Albert Collet, Inventor.

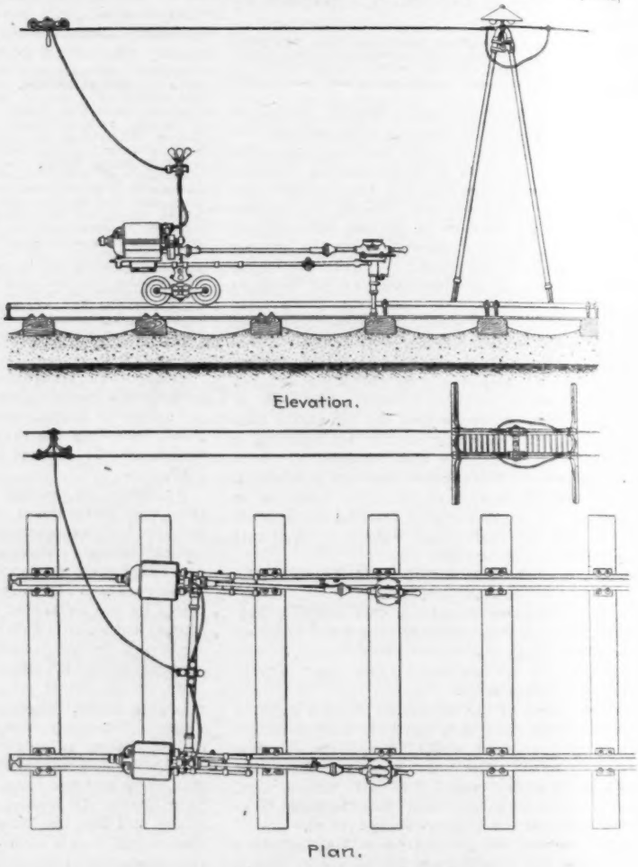


FIG. 2. MACHINE FOR DRIVING AND REMOVING SCREW-SPIKES.

A Venturi meter was placed on the 18-in. discharge pipe from the reservoir. Mr. James Deas, Assoc. M. Inst. C. E., is at the head of the water department of Warrington.

On Saturday forenoon the members and guests of the association visited the pumping stations of the Hull water-works. The supply is drawn from deep wells sunk in the chalk. The wells are connected by tunnels discharging into pump wells. The whole city is supplied by direct pumping, but a 600,000-gallon covered reservoir is now being built, apparently for a suburban district dependent on a single main.

It may be added that as early as 1616 a company was formed to provide an improved water supply for Hull. A cistern was erected and water pumped to it by horse power. Elm logs were used for distributing the water.

M. N. B.

Hull, June 10, 1904.

MACHINES FOR SPIKING AND TAMPING RAILWAY TRACKS.

In the development of labor-saving devices, their application to the work of railway maintenance of way has not as yet received very much attention, although in railway bridge maintenance some extensive use has been made of portable air compressor plants to supply power for pneumatic drills, chisels and riveters, etc. A pneumatic spiking machine (with a boiler and small steam hammer mounted on a hand car) has been employed in street railway track work in Detroit, and various machines for tamping ties have been invented, but have not been brought to any practical use in this country. In the May number of the "Revue Generale des Chemins de Fer" we find an interesting article by Mr. M. Regnoul, Engineer of Track of the Paris, Lyons & Mediterranean Ry., describing the successful application of machinery for driving screw spikes and tamping ties. The apparatus was designed by Mr. Albert Collet, who made his first machine in 1899. At the present time, the spiking machines have been used exclusively in relaying tracks in operation for a length of 30 miles, and the railway company has made a contract for their use.

The apparatus consists of (1) a generating plant mounted on a car, which can travel on the road or the track; (2) a double wire transmission line, and (3) the various tools, these last taking current from the transmission line by trolleys and short lengths of cable. The generating plant, Fig. 1, is mounted on a pair of rails or a platform shown in Fig. 2, which also shows the spiking machines.

The spiking machine consists of an electric motor turning on a vertical pivot and driving a horizontal shaft with flexible joints. An extension of the shaft carries two loose bevel gear wheels, one for the forward movement in screwing the spike, the other for the reverse movement in unscrewing the spike. This gear drives a vertical shaft, which can be instantaneously connected by a clutch to the tool which grips the spike. This tool is normally at rest, so that the man in charge can slip it over the square head of the screw spike, and then throwing in the clutch and bearing down lightly on the machine the spike is rapidly screwed home. The tool makes about 400 revolutions a minute. Two of these machines are mounted on a wooden frame carried by two small flanged wheels on each rail, and the flexible joints enable the spikes to be driven on each side of the rail. As the motors can be revolved, the machine on one side can, if necessary, handle the spikes of the opposite rail. The weight of each motor and its machinery is about 330 lbs. while the truck weighs 88½ lbs., and the motors can be easily dismounted. The tamping machine, Fig. 3, is practically the same as the spiker, but operates an inclined shaft with a reciprocating motion; this acts as a hammer upon the end of the tamping bar, which bar is drawn back by a spring after each stroke. The machine makes about 400 strokes a minute. A portable telephone line is run from the plant to the nearest

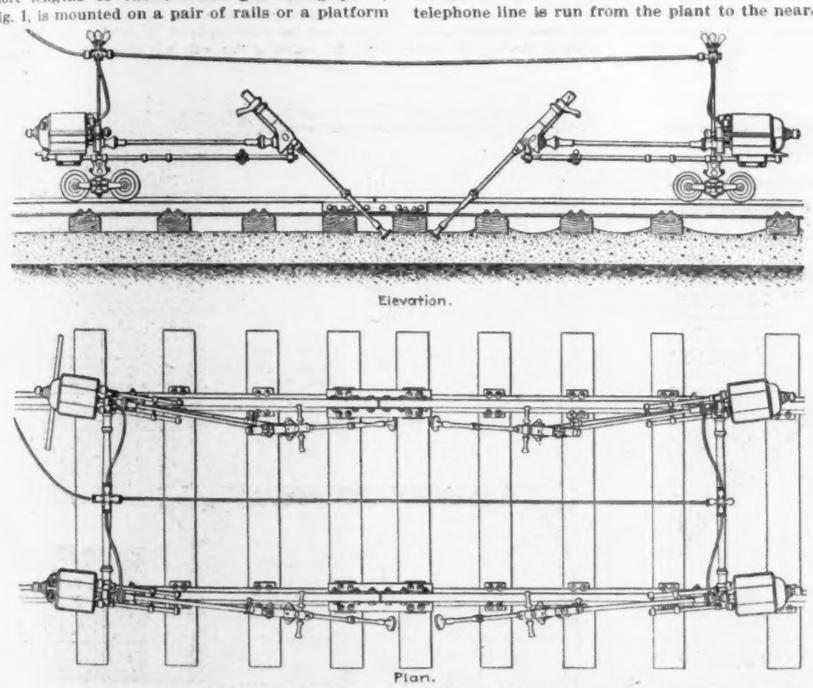


FIG. 3. MACHINE FOR TAMPING BALLAST.

of old ties alongside the track. The oil engine first used was not satisfactory or economical, and the plant now comprises a vertical tubular boiler and a 25-HP. vertical compound engine with two tandem cylinders. The engine drives a generator furnishing a direct-current of 220 volts, which is low enough to prevent disagreeable results in handling the tools. The weight is about 7,260 lbs., empty. For traveling on the roads, there are two large wide-tired wheels. At each corner of the machine is a castor with two small flanged wheels, and a screw arrangement enables the axle carrying the road wheels to be raised or lowered at will.

The two conductor wires are carried side by side on supports consisting of a pair of light A-frames, built of steel tubing. These are placed parallel with the track, and have cross pieces at the bottom to ensure stability. On top of the A-frame is a hood with sockets for two incandescent lamps. The wires are in lengths of 164 ft. and are attached to connections on the frames, which are set at intervals of 164 ft. This arrangement is

station, or to a cabin for the watchman sent out to protect the work.

With two men to operate the tools and two to hold up the tie with crowbars, it takes 9½ minutes to drive the 200 spikes in a stretch of single track 59 ft. long. With two men, 100 old spikes can be removed from the same stretch of track in 4 minutes. With four tamping machines and six men (one to each machine and two to feed the ballast), a tie can be tamped in 30 to 35 seconds, including the time of moving from one tie to another, or about 110 ties per hour. Both spiking and tamping are done about seven times as fast as by hand, and about 7,000 ties in sand ballast have been tamped in this way. The tabulated results of hand and machine work in individual sections of line may be summarized as follows:

	Track renewed per day.		Track renewed per man per day.	
	Hand work.	Machine work.	Hand work.	Machine work.
	ft.	ft.	ft.	ft.
A	633	1,114	15.48	22.43
B	1,002	1,393	22.30	26.99
C	749	1,890	20.12	21.84
D	811	1,850	20.80	26.14

DESIGN FOR REINFORCED CONCRETE BINS FOR GRAIN ELEVATORS.

Reinforced concrete grain elevators have been built in Europe for more than 20 years and they are at present practically the only form of fireproof elevator construction that is employed abroad. The usual practice is to make the bins rectangular and to support them on concrete-steel columns resting on either separate or continuous footings of concrete. As good examples we may mention the 1,200,000-bushel elevator at Genoa, Italy, with 10 × 14-ft. bins 57 ft. high, and the Dunston-on-Tyne elevator in England with 14 × 14-ft. bins 60 ft. high. In America there have been only a few grain elevator bins built of reinforced concrete and these have all been cylindrical with their bottoms resting directly on the ground and with conveyor tunnels underneath. Recently, however, American elevator designers have turned their attention toward developing a rectangular bin construction with supporting columns. One of the most notable of the designs which have been thus developed is shown by the accompanying drawings.

The drawings illustrate the main frame or working floor story, the bin hopper bottom, and the bin wall construction of the type of elevator known as a terminal working elevator, at which the work to be done consists in unloading cars, cleaning and mixing grain, and loading vessels. To understand thoroughly the significance of the construction illustrated it is necessary to know the structural characteristics of the type of elevator designated.

This class of elevator requires a working floor story having a clear height of 20 ft. between the bottoms of the bins and the level of the railway tracks, two of which usually run through the house to permit the cars to be unloaded directly into the elevator legs. On this floor the car unloading and moving machinery, the cleaning machines, etc., are also located. To give the required head room with hopper bottom bins the columns must have a length of about 23 ft. from floor level to the underside of girders. The spacing of the columns has to be such as to give sufficient room for the cars and also to permit the legs to be spaced so that the doors of a line of coupled cars will come approximately opposite each leg. The best width of a building of this type is seven bays or approximately 100 ft, and for a million bushel storage capacity the length would be 14 bays or 198 ft. The bins employed are usually 75 ft. deep and 17 ft. square and on top of them comes a five-story cupola set over the three center rows of bins and running the full length of the building. In the cupola all the weighing and the distribution of the grain to the different bins is performed.

The reinforced concrete construction illustrated meets the structural conditions just outlined. Its original and prominent features are the columns, the bin hopper bottoms and the bin walls, and these have been worked out by Mr. J. A. Jamieson, Consulting Engineer, of Montreal, Canada, who has patented the bin bottom and the bin wall construction in the United States and Great Britain, and has applications for patents pending or partly allowed in Canada and some of the European countries. The drawings are to a great degree self explanatory. They comprise a sectional plan and sectional elevations of the bins and details of the column and girder construction.

The first feature of note is the column construction. As will be observed this is the hooped construction which has recently become prominent through the publications of Mr. Considère. The important thing to be noted, however, is that this type of reinforcement was independently evolved by Mr. Jamieson. In a letter to us Mr. Jamieson says:

> The principle of the column is of original design by the writer, my experiments in this direction first starting about three years ago, and being based on the known manner in which a concrete prism fails when tested to destruction. I first tested steel tubes filled with concrete in which the tube acted as a binder against the swelling and bursting out of the concrete; next I tested steel rings tied to small vertical rods so that the steel would be protected by being fully embedded in the concrete, and, finally, the spiral reinforcement was adopted. Before I had my tests completed, however, I was forestalled by the publication of Considère's tests which he had been conducting concurrently with or slightly in advance of mine in their latest shape.

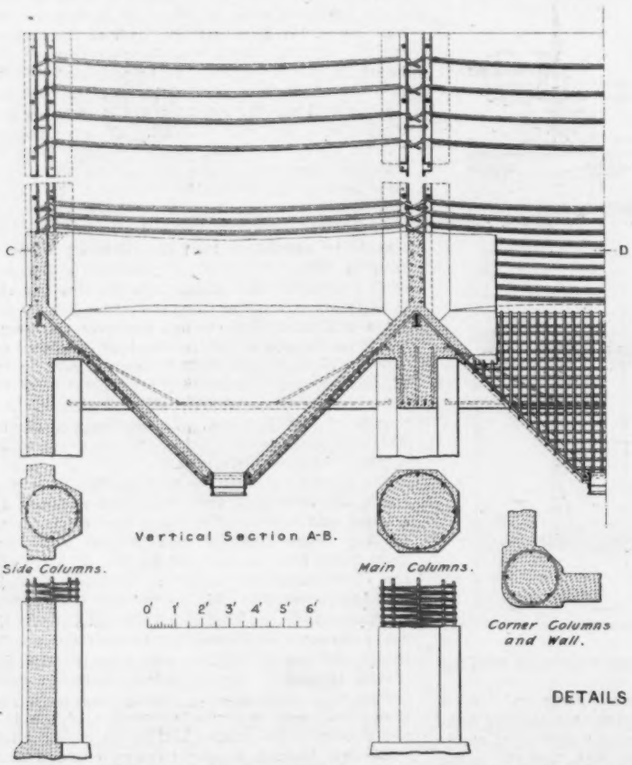
The column construction is made entirely clear by the drawings. These columns support two sets of girders at right angles to each other. As will be seen these girders so bond into the bin bottoms as to form a sort of T-section, and are continuous with the vertical bin walls. Their reinforcement consists of two straight and three "catenary" bars, and the straight bars reach into the columns and are bent upward at the ends to give a mechanical bond.

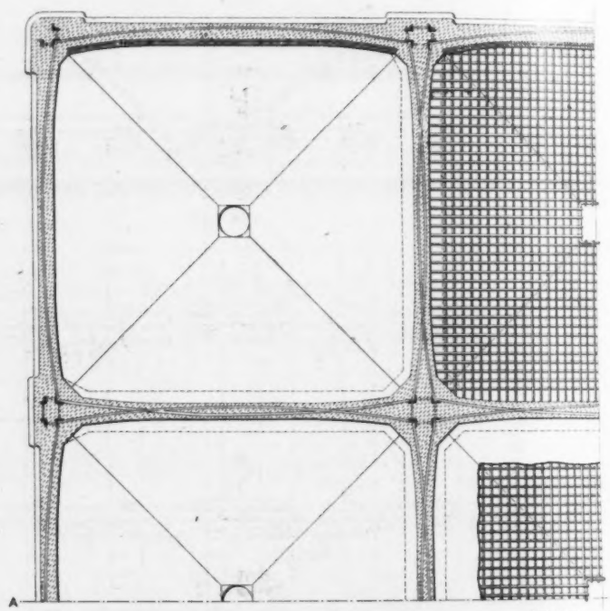
The bin bottoms are reinforced by two series of rods intersecting at right angles. Each rod, with the exception of the four at the center of each series, forms a complete truss across the bin bottom and has its ends hooked over the bulbs of deck beams, set over the supporting girders. The two sets of rods intersect each other at the corners so that, starting at the sides of the bin, the parts of the rods running down on the angle of 45° are of increasing length while the horizontal parts are of decreasing length. At points of intersection the horizontal part is preferably carried under the part on the angle, since the parts running down on the angle must take all the strain due to vertical load while the horizontal parts act as the tension members of the triangular concrete slab in which task they are assisted by the angle parts in proportion to their distance from the neutral center. The strain on the ends of the bars where they bend over the deck beams is very light since the required amount of steel is governed by the amount necessary to give the requisite strength to the slab.

In reference to this form of bottom construction, Mr. Jamieson claims that not only is a fireproof construction obtained, but one which is exceptionally strong and stiff and one which can be built for approximately half the cost of a bottom built of steel plates which bulge very badly when loaded. Mr. Jamieson has had this type of bin bottom in practical use for over a year in bins 14 ft. square and 66 ft. deep and there is not yet a visible crack, and when the bins are loaded there is practically no measurable deflection.

The bin wall reinforcement consists of a series of horizontally disposed wall rods fastened by hooked ends to vertical angles set directly over the main building columns. These vertical angles are arranged in sets of three or four, the angles of each set being spaced and connected by bolts and punched with holes to receive the ends of the wall rods. These take the tensile stress due to the resultant grain pressure, and are curved to an arc with the ends bent to such an angle that when hooked into the vertical supports they lie at an angle to both the vertical and horizontal, thus providing for the horizontal pressure and assisting to carry the vertical load into the greater area or thickness of concrete formed by the wall intersections which come directly over the main columns. The exterior walls require only one set of rods, while the interior walls have two sets to resist the pressure due to the grain in either of the two bins between which they form the dividing walls. The sections of the concrete in the bin walls and in the hopper bottoms are clearly shown by the drawings. It may be noted here also that the bin bottoms in the design illustrated have a factor of safety of 6½ and the bin walls have a factor of safety of 6 for the horizontal pressure and of 9 for the vertical load, or a maximum load on the concrete at the bottom of the wall of 310 lbs. per sq. in.

For the information from which this description has been prepared, we are indebted to Mr. J. A. Jamieson, the inventor of the system of bin construction described.





*Part Sectional Plan through C-D.

DETAILS OF REINFORCED CONCRETE GRAIN ELEVATOR CONSTRUCTION.

J. A. Jamieson, Consulting Engineer, Montreal, Canada.

THE TREATMENT OF MOORLAND WATER TO PREVENT ACTION UPON LEAD PIPES.*

By C. Clemesha Smith, Assoc. M. Inst. C. E., and E. M. Chaplin, F. C. S.

The catchment area from which Wakefield obtains its water supply consists chiefly of moorland. Peat covers the surface, varying from 6 ins. to over 20 ft. in thickness. Underlying the deeper peat in many places are deposits of clay and outcrops of shale. In many parts of the moor where the peat is deep and rests on clay, the ground is soft and marshy, and the water running from it has a peaty color and taste.

Dr. Houston has proved beyond doubt that it is by contact with the peat that the water acquires its acidity and power to attack lead.

A portion of the water-works were completed and the water supplied to the city and out districts in 1888. During the following three years complaints as to lead poisoning gradually increased until early in the year 1892, when they became so numerous that the corporation called in Dr. Percy Frankland to investigate the whole matter, and report as to the steps to be taken to counteract the action of the water upon the lead pipes. After a detailed examination of samples of water from the various feeders and streams, from the several reservoirs, and from various draw-off taps in the area supplied, and [illegible] laboratory experiments as to the best method [illegible] interacting the solvent action of the water, Dr. Fr[illegible] presented a complete report to the corporation [illegible] found that whilst the gathering ground yielded a wa[illegible] exceptional organic purity admirably [illegible] both for dietetic and industrial purposes, yet it h[illegible] very marked action upon lead, but one which it is q[illegible] sible to remove by several distinct methods of tr[illegible]t—namely: (a) treatment with carbonate of soda; (b) [illegible]ment with finely-divided carbonate of lime or chal[illegible] (c) filtration through finely-granulated limeston[illegible].

The first method (carbonate of soda) w[illegible] commended as an immediate measure, because of th[illegible]plicity with which it could be applied; its applicat[illegible] involving no great expenditure in the way of plant. [illegible]ther point in its favor lay in the fact that it could [illegible]dded to the water as it entered the Ardsley reservoir[illegible] large storage reservoir near the city) without alter[illegible] the appearance of the water.

The second method was considered inap[illegible]able at the time, as it was deemed that the use of lime [illegible] chalk would have rendered the water cloudy, and hence this treatment could not have taken place as the water entered the Ardsley reservoir, there being at that time no subsequent filtration. The treatment might have taken place as the water flowed down the Moss Moor Catchwater into the Ringstone reservoir, but that course would have involved the treatment of the whole of the compensation water, as well as cartage of the lime a distance of four to five miles over a difficult country. Hence the soda treatment was adopted as a temporary measure.

A series of eight tanks, each capable of holding 120 U. S. gallons of water, was fixed near the inlet into the Ardsley reservoir. The carbonate of soda was prepared by the ammonia-soda process. Other descriptions of soda were used from time to time, but in no case were the results as uniform as when the above soda was in use.

The carbonate of soda was added to the water in the tanks and the water agitated by paddles turned by hand until the whole of the soda was dissolved. The amount of soda required to render the water harmless was found by Dr. Frankland to be 2.92 grains per U. S. gallon. The tanks were used as storage tanks for the stock solution of soda, and a continuous stream of the solution was passed into the inlet gage basins, the quantitly being regulated according to the flow of water over the gages.

Owing to various causes, the action of the water (taken from the main as it flowed into the Ardsley reservoir) upon lead varies very considerably. During a period of drought it is found that the water flowing into the reservoirs at Rishworth has a comparatively slight action; if, however, a sample be taken immediately after a heavy flood which has broken a prolonged drought, the activity of the water as regards lead is very pronounced. The samples which have shown the most activity have been those taken from the main at Ardsley, when water was being drawn from the lower levels of the Ringstone reservoir. The bed of the latter contains a considerable quantity of peat, and as the water had been a long time in

*Abstract of a paper read before the annual convention of the British Water-Works Association at Hull, June 9 to 11, 1904.

contact with the bottom, it is probable that the prolonged contact had increased the acidity of the water.

Frequent tests were made as to the action of the water in order that the amount of soda might be varied in accordance with the acidity of the water. The object being to determine the amount of lead taken up during prolonged contact, under conditions approximating as closely as possible to those that regularly occur in practice, the method of testing differed from that employed by Dr. Houston. The usual plan of allowing the water to stand for a period of 12 hours in lead pipes was adopted. Owing to the nature of the test, different results are not always strictly comparable, but if applied in the manner about to be described, figures are obtained which are reasonably concordant. Absolutely new pipes are not used.

For each test two pipes were taken (2 ft. long and having an internal diameter of ¾-in.), one of which had been in use somewhat longer than the other, and when this older pipe ceased to give results similar to the newer one, it was discarded and another pipe taken into use which had been brought into condition. To effect this purpose, a piece of new lead pipe of the size mentioned was charged with town's water, proved to be lead-free, the ends were closed by means of ordinary corks, and after a period of 12 hrs. had elapsed the water was emptied out and the amount of lead taken up determined colorimetrically in the usual manner. The tube was carefully brushed out on every occasion before being filled with a burette brush, the wire handle of which was protected by being wrapped round with thick tape, so that the surface of the inner walls of the tube might not be scratched. The process of filling and testing was repeated every day until this new tube gave results comparable with those obtained with the one beside which it was to be used. The brushing of the pipes immediately before charging causes them to remain serviceable for a longer period than they would otherwise. It was found advisable to have two sets of tubes in use, one for really acid waters, and the other for waters that had been treated.

During the past eight years the average activity of the water from the Ringstone main at Ardsley, as ascertained by the above method, has been such that it has taken up 1 grain of lead per U. S. gallon during 12 hours' contact. The period of least activity occurred during the drought in the year 1901, when the water took up 0.36 grain per U. S. gallon during 12 hours' contact. The maximum activity was reached in December, 1902, the water being drawn from the Ringstone reservoir when it was half empty, and at the same time flood water was bringing in the first washings of the moors after a second dry summer; a sample drawn at the time, from the Ringstone main at Ardsley took up 2 grains per U. S. gallon during 12 hours' contact.

The cost of the soda treatment varied with the cost of the soda (from £4 3s. 4d. to £4 18s. 4d. per ton), the labor required and the amount of soda used, and worked out from 18s. to 22s. 6d. per million Imp. gallons ($3.64 to $4.55 per 1,000,000 U. S. gallons) of water treated.

Although this treatment proved perfectly satisfactory, from the outset it was looked upon only as a temporary method. About the date of the lead-poisoning scare it was found that, owing to other causes, it would be necessary to filter the water before distribution.

In the year 1894 the corporation were considering the advisability of constructing filter beds, and experiments were carried out by Professor Dewar and Mr. Henry Rofe, M. Inst. C. E., with a view of further ascertaining the value of sand filtration for the purpose of neutralizing the action of water upon lead pipes. Their experiments were made with sand from the River Trent, the filter consisting of 3 ft. of sand upon a bed of pebbles. They found that if the water was passed through the filter at the rate of 360 U. S. gallons per sq. yd. per diem, the action upon lead was removed. Professor Dewar says, however:

> How long this preventative action on lead will continue, or whether the sand will lose in time its efficiency, can only be ascertained by actual experience of this particular sand.

In 1898 one of the authors was instructed to prepare a filtration scheme for the city, and experiments were made with a view to ascertaining how long the action of the sand in neutralizing the affinity of the water for lead could be relied upon. In the first case, sand from the River Ouse above York was experimented with. The water was filtered through 3 ft. of sand supported on 1 ft. 6 ins. of pebbles, and was passed through at the rate of 320 gallons per sq. yd. per 24 hours. Another experiment was made with a fine-grained sample of sand obtained from Leighton Buzzard. The depth of sand and pebbles and rate of filtration were as before.

From these experiments it was found that filtration through either Trent or Ouse sand was at the outset sufficient to bring the action of the water upon lead within the limits of safety, but that in course of time it would be necessary to treat the water in some other way. As a result of the foregoing experiment it was decided to use Trent sand in the proposed filter beds, and to make arrangements whereby the water could be treated with chalk and lime prior to filtration. The filter beds have a depth of 3 ft. of Trent sand resting on 1 ft. of gravel and broken stone. Filtration was commenced on Jan. 11, 1902, the water to be filtered being brought direct from the Ringstone main at Ardsley, so that the beds were dealing with water which had had no preliminary treatment. The following table shows the effect of filtering the untreated water through the newly constructed beds:

No. of days filter had been in use.	Lead taken up, after 12 hours' contact: By filtered water in grains per U.S. gallon.	Unfiltered water in grains per U. S. gallon.
6	0.05	...
23	.08	.67
42	.06	...
69	.11	...
72	.14	...
91	.18	.93

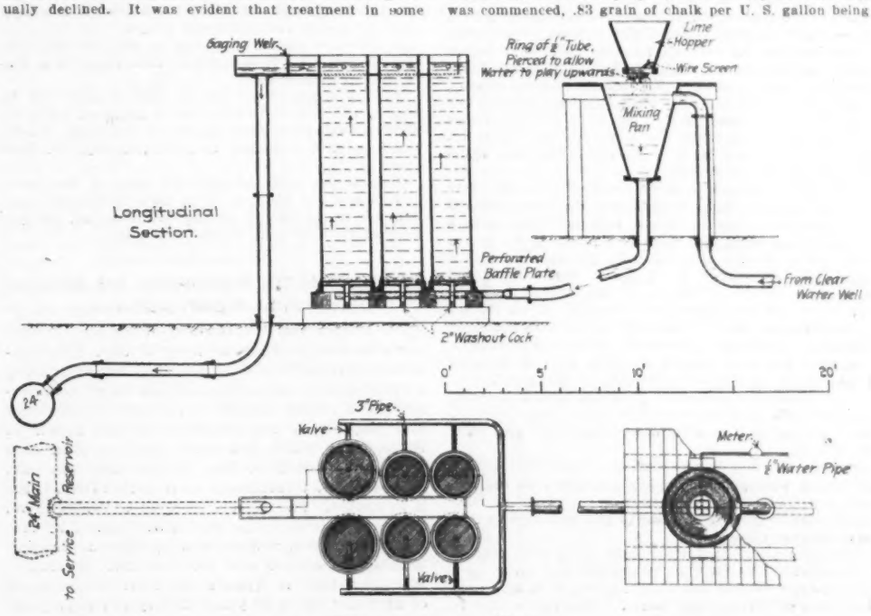
The actual working of the filter beds thus corroborated the experiments made with the Trent sand, and showed that the action of the beds in neutralizing the water gradually declined. It was evident that treatment in some form must be adopted, and chalk was added at the rate of half a grain per gallon to the water prior to filtration, by which means the action upon lead was reduced to within the desired limits.

Dr. Percy Frankland in his report to the Corporation (referred to in the early part of this paper) mentioned a series of experiments which he made with water treated with various quantities of chalk and lime together and separately, upon new and old lead pipes. He found that whilst the addition of chalk alone was more beneficial in the case of new lead pipes, a further addition of lime-water assisted materially to prevent action upon old lead pipes. He, therefore, recommended the addition of 2.92 grains of chalk and 3.75 grains of lime per U. S. gallon, with a warning against exceeding that quantity of quicklime.

Further laboratory experiments were now made, and it was decided to treat the water with 1.66 grains of chalk and .83 grain of quicklime. This treatment was commenced at the end of October, 1902, and it was quickly found that a layer of chalk and lime was deposited on the surface of the sand, which clogged the bed so rapidly as to cause a material increase in the labor bill. In order to avoid this extra labor and at the same time prevent waste of material, the quantity of lime and chalk was gradually reduced, and at the same time the water supplied to the city was frequently tested with reference to its action upon lead. By Jan. 1, 1903, the amount had been reduced to 0.83 grain of chalk and 0.42 grain of lime per U. S. gallon. As this treatment materially reduced the labor of cleaning the surface of the filter beds, and as no appreciable rise took place in the amount of lead taken up in the "standard pipes" in the laboratory, this treatment was continued until May 26, 1903, when the plumbo-solvent power of the water was found to have risen. About this time it was found that an examination of water drawn from service pipes sealed over night yielded results which did not quite coincide with the results obtained from tests with the standard pipes, the difference being possibly due to the age of the pipes, and to difference in the quality of the lead. It was therefore, considered desirable to test water drawn from various service pipes, new and old, after standing over night in such pipes. It had been noticed that ever since the commencement of this treatment with lime and chalk prior to filtration, the water was becoming gradually less alkaline. It was naturally thought that an increase in the quantities of chalk and lime added prior to filtration would cause a rise in the alkalinity of the water; the quantities were, therefore, doubled, but without appreciable result. During June (and July.—Ed.) experiments were made using different proportions of chalk and lime.

These experiments clearly showed that a loss of alkalinity had taken place during the passage of the water through the filter beds. As far as the authors are aware, this unexpected result has not been observed previously, nor has it been foreshadowed in any of the hints as to treatment furnished by various authorities. No satisfactory explanation has at present been arrived at.

After obtaining the result of this experiment, it was decided to add "lime water" after filtration, a small quantity of chalk being added before filtration. A temporary plant, consisting of a series of wooden tanks and a mixer, was installed for this purpose, and on July 17 treatment was commenced, .83 grain of chalk per U. S. gallon being added before and 3.33 grains of lime per U. S. gallon after filtration.



APPARATUS FOR PREPARING LIME WATER FOR NEUTRALIZING ACIDITY OF WATER SUPPLY, WAKEFIELD, ENGLAND.

It was found, however, that the temporary plant was not large enough to deal properly with 3.33 grains of lime per gallon, and the quantity was reduced. The following table shows the effect of this treatment, which has been continued up to the present time:

Date.	Quantities added in grains per U.S. gall.: Chalk.	Lime.	Alkalinity in grains pr U. S. gall., Na_2CO_3.	Lead taken up in service pipes in 12 hours, grains per U.S. gall.
July 18, 1903	0.83	3.33	0.53	0.092*
July 27, 1903	.83	3.33	.75	.058 & .033
Aug. 19, 1903	.83	2.5	1.33	.017
Aug. 31, 1903	.83	1.66	.93	.027
Sept. 4, 1903	.83	.83	.75	.025
Sept. 14, 1903	.83	.83	.52	.025
Oct. 16, 1903	.83	.83	.44	.025
Nov. 16, 1903	.83	.83	.42	.020
Dec. 15, 1903	.83	.83	.43	.019
Jan. 23, 1904	.83	.83	.35	.025
Feb. 18, 1904	.83	.83	.08	.267†
Feb. 20, 1904	.83	.83	.22	.090
Feb. 23, 1904	.83	.83	.31	.05
March 21, 1904	.83	.83	.53	.017
April 19, 1904	.83	.83	.44	.017

Remarks: *Treatment commenced previous day. †Lime treatment suspended owing to breakdown, Feb. 16 to 19.

Note.—The quantity of lead found in the water after 12 hours' contact with the pipes—.025 gr. per U.S. gallon—is very minute, being equal to one part in 2,500,000. This quantity has been found under similar circumstances in water from the service pipes of towns where no trouble on the score of plumbism has ever been met with. Tested by Dr. Houston's method, as described in the second volume of his report to the local government board, the Wakefield water under the present treatment, shows no trace of lead.

The foregoing table affords evidence that the present method of treating the water gives satisfactory results, and a plant of a more permanent character has just been completed. A drawing of this plant accompanied the paper. It consists of a conical iron hopper closed at the bottom by a copper-wire screen of 1-10-in. mesh; about 3 ins. below the screen is fixed a ring of ½-in. pipe pierced with holes on the upper side, and connected to a water main, so that the jets of water pass through the screen, and bring down the lime (which is slaked and riddled prior to being put in the hopper). A 6-in. main brings filtered water from the clear water well, and the lime-water and clear water become well mixed in the mixing pan. The water then passes to the settling pipes (two of which are 24 ins. in diameter, and four 18 ins. in diam-

eter), enters the bottom, passes slowly up and overflows into a trough, passes over a gage and thence down a 6-in. pipe to the mains which convey the filtered water to the service reservoir.

By means of this apparatus a clear lime-water is obtained without the use of power for mixing, or filtering apparatus for clarifying. The grit and foreign matter contained in the lime is left on the surface of the screen at the bottom of the lime hopper, which is removed and cleaned daily. The lime settles at the bottom of the vertical pipes, and the water passing slowly upwards through it becomes heavily charged with lime in solution. The lime hopper shown on the drawing has been in use for nearly two years, and has proved to be more satisfactory than several power-driven methods which were first used to add the lime. The jets can readily be regulated so as to empty the hopper in a given time, there are no working parts to break down, the only parts to be renewed are the screen and the ring of tubing which forms the rose, and these will last for over six months. A similar hopper and jet is used for the chalk which is added before filtration, and has been used for mixtures of lime and chalk.

The vertical settling pipes have only been brought into use during the latter part of April, so that at present nothing can be said of the efficiency of the method, except that one week's use leads to the expectation that excellent results will be obtained.

The cost of the soda treatment was stated in the early part of this paper to be from $3.64 to $4.55 per 1,000,000 U. S. gallons. The chalk now used is Yorkshire in a finely divided state, and costs 30s. per long ton at the filter beds; the lime costs 14s. 9d. per long ton at the filter beds. (Just under 0.4 ct. per lb. for the chalk, and 0.16 ct. for the lime.) The cost of labor and materials for the chalk and lime treatment is from 4s. to 4s. 6d. per million Imperial gallons (83 to 93 cts. per 1,000,000 U. S. gallons). It must be remembered, however, that the soda treatment was used without filtration, whereas filtration is now combined with the chalk and lime treatment.

In all the experiments which have been made it has been observed that it is not sufficient merely to render the water neutral, as it exerts a solvent action upon lead when alkaline.

The question may be asked whether some other method of dealing with plumbo-solvency might not be adopted, and it will, therefore, be interesting to glance at some which have been suggested, and to give reasons why they have not been adopted.

The exclusion of flood water from the domestic supply is regarded by some as the best preventive of action upon lead, the dry weather flow being neutral, or at all events much less acid than flood waters. This course may be possible where the yield of the gathering ground is much in excess of the requirements of the district served, or where only a portion of the drainage is from peat areas, the loss of which in flood times is not felt, or in some cases it may be possible to utilize flood water for filling the compensation reservoirs, retaining the dry-weather flow for the town's consumption. Many water authorities (the City of Wakefield being one) draw their water from areas largely or almost entirely covered by peat, and the proportion of acid water is so great that it cannot be spared; hence it is impossible to run it to waste or to utilize it for compensation purposes only; further than this, owing in many cases to the disposition of the ground and catchment areas, it is not possible to arrange the reservoirs so that storm water can be used for compensation purposes only.

If the exclusion of flood water from the domestic supply is to be a sufficient safeguard against acidity, the whole of the peat must be removed from the bed of the impounding reservoir, as contact with the peat would render neutral water acid. This procedure would not in all cases be entirely wise, many water-works engineers of high repute objecting to the removal of the surface covering on the ground that it may contribute to the watertightness of large reservoirs (reservoirs covering 50 to 100 acres or upwards are here referred to). Moreover, clay is often met with below the peat, and the authors are familiar with the result of exposing large areas of clay to the action of water in a reservoir. In one reservoir some 20 or 30 acres of clay were exposed during dry summers, the water being drawn very low; as it rose in the autumn and winter, the water washed over the clay surface, and became discolored by minute particles of clay in suspension, which sometimes took four or five months to settle out of the water. Under such circumstances filtration becomes imperative, and even where filtration is already in operation the labor bill is increased in that the filters have to be scraped more frequently.

Service pipes of metals other than lead, or lead lined with tin, are advocated by many. The authors have found that wrought-iron pipes, whether protected by special processes or not, are unsatisfactory, as after a year or two the water passing through them often acquires a dark brown color, and in the course of from seven to ten years the pipes become so furred up that they have to be replaced. Tin-lined lead pipes have also been tried without success, tests showing that lead is taken up almost as freely from these as from ordinary lead pipes. It may be possible to obtain a pipe from which lead cannot be taken up, and which shall at the same time be as cheap, as durable, and as easily manipulated as lead, but such a pipe has not as yet come under the authors' notice, and even if such a pipe were found, the many thousands of lead services now in use have still to be dealt with. Hence it was considered that the only solution of the difficulty lay in the treatment of the water so as to prevent it from taking up lead.

Limestone rubble foundations to filter beds, and limestone rubble screens in the stream courses, have been adopted in many instances, but, as Dr. Percy Frankland remarks in a report on the Wakefield water:

> There cannot be any doubt that the latter (limestone) would rapidly deteriorate through particles of limestone becoming coated with a slimy deposit, which would prevent actual contact with the water.

It may be as well to close this paper with a brief summary of the conclusions arrived at:

(1) Treatment with carbonate of soda is easily carried out, and is effective, but at the same time, it is a very expensive method of treating acid waters.

(2) Filtration through sand may be effective whilst the beds are new, but the sand rapidly loses its power of preventing plumbo-solvency.

(3) Only a limited quantity of lime or chalk can be usefully added to the water prior to filtration, for if the water is rendered strongly alkaline at this stage, it loses a portion of its alkalinity in passing through the filter beds.

(4) With the water experimented upon, it was found best to add one grain of chalk prior to filtration, and from one to two grains of lime after filtration, the lime being added in the form of clear lime-water.

EXPERIENCE IN THE MAINTENANCE AND REPAIR OF STEEL FREIGHT CARS.

The history and development of the steel freight car was described in our issue of Jan. 7, in connection with a review of the steel car in railway service, and in the present article we give the results of a recent inquiry as to current experience and practice in the maintenance and repair of these cars. Since practically all the steel cars now in service have been built within the past five years, no information as to their eventual life is available. The experience with them, however, indicates that their life will be determined by corrosion or abuse, rather than by general decrepitude as is the case with wooden cars. In fact, it is known that in France the steel underframes of cars last 30 to 40 years if they are kept properly painted. From the results of experience in this country as to service, repairs and maintenance, it is evident that the steel car presents a decided ultimate economy as compared with wooden cars, and that there is no prospect of a halt in the introduction of the steel freight car.

In 1898, when the manufacture of pressed steel cars of the modern type had just been commenced, an estimate of the comparative cost of maintenance of these cars and wooden cars was prepared by Mr. Charles T. Schoen, of the Schoen Pressed Steel Co., the comparison being drawn between a 30-ton wooden car, with a life of 15 years, and a 50-ton steel car, with a life of 30 years. This estimate was discussed in our issue of Jan. 19, 1899, and it was shown that the actual cost for 30 years would be $2,868 for the steel car and $3,195 for two wooden cars, or a difference of $327 in favor of the former. In addition to this, the old steel car would have a much higher scrap value than the two old wooden cars, the former being sometimes estimated at $10 per ton.

When steel cars first began to be introduced, many objections were urged against them on the ground of the expense that would be required for maintenance and repairs, and the difficulties involved in straightening, repairing and renewing parts damaged in service. It seemed to be assumed that in regular service the steel cars would suffer at least as much damage as wooden cars, and that the work and expense of making repairs would be materially greater. After several years of experience with many thousands of steel cars, this idea has been proved to be unfounded, and railways have little trouble in keeping their steel cars in proper condition. Of course the character of the repair work is of a different character from that of repairs to wooden cars, and requires some special equipment for cutting out rivets and members, riveting, heating, straightening, etc. As the experience with this class of repairs develops, however, it is found that much of the work can be done without cutting out the parts and even without heating them. It is also found that the ordinary car-repair gangs easily become capable of efficiently handling the work, and some railways are already introducing the piece-work system of payment for steel car repairs.

It is very generally known that in freight service a considerable proportion of the damages to cars are due to recklessness and rough usage, and are not attributable to the ordinary exigencies of service. Thus in switching cars at yards, through haste and lack of care on the part of the switching crew, cars are thrown together or against the bumpers with such force as to derail them, knock them off their trucks, smash the sills, break the couplers and draft rigging, or send the load through the end of the car. Some roads have taken especial means to enforce good discipline at large yards in order to check the reckless handling of cars and the consequent excessive charges for repairs, but as a rule the cars are subjected to a certain amount of abuse in every yard. The conditions are aggravated when steel cars are switched, as they are popularly supposed to be able to take any kind of rough treatment, and there is little fear of breaking sills or doing other conspicuous damage. In fact the steel cars are commonly termed "battering rams" and "battleships" by the yard men, and these terms give some idea of the way in which the men regard these cars when performing the switching work. In spite of this, however, the ordinary repairs to steel cars are very slight.

As these steel cars are more expensive and often require a large investment, it might seem reasonable to expect that greater care would be taken with them, but as a matter of fact they are subjected to greater abuse than the wooden cars, and the fact that they have shown such good results in spite of this treatment is strong evidence as to their practical and economical advantages in railway service. A large proportion of the steel cars are operated in the coal and ore traffic, and are subjected to most unmerciful handling at the loading and unloading points. If the load sticks, freezes or arches, the car is likely to have a fire built under it or to be pounded with sledges and crowbars in order to start the load. This peculiar class of treatment was described in an article on "The Painting of Steel Cars," in our issue of Oct. 8. With wooden cars, the pounding with bars and hammers produces little damage, but with steel cars it not only destroys the paint but bends and bruises the metal in such a way as to be the cause of future trouble.

The evils being realized and admitted, the question is how to reduce them to a minimum, and also how to reduce the maintenance expenses directly chargeable to these evils. The first step plainly is that of enforcing good discipline on the part of the switching crews, which can be done without in any way reducing the rapidity or efficiency of their work. This, however, does not provide for the conditions incident to the unloading of steel cars. When a train of cars of coal or ore arrives at a dock, blast furnace plant, etc., immediate unloading is desired, and if the load sticks or is frozen, the men are not apt to be careful in selecting means for loosening it. The interior construction may have much to do with difficulty in loading, as openings too small, obstructed, or so located as to cause the load to arch, may be responsible for some of the trouble. Freezing cannot be provided against, but where difficulty is frequently found from this cause, it should be made known to the officers, who should see that steps are taken to remove or remedy the trouble by carefully planning some system of thawing or loosening the loads without leaving this to the ingenuity or clumsiness of the unloading gangs.

One of the principal troubles which it was predicted would be experienced with steel cars was that of corrosion. But while this has certainly been very troublesome in certain cases, yet taking it all in all, it has been very much less serious than might be expected, and may be still further reduced by improvements in the construction of the cars, and by care in keeping the parts painted. Unfortunately, freight cars are not often spared for painting as often as they should be, or allowed to remain out of service long enough for painting in the most efficient manner. The greatest corrosion occurs in coal cars, where moisture

carries acids and destructive elements to all parts of the framing, hoppers, etc. This extent, of course, varies with the character of the coal and the amount of moisture, but there is no longer any apprehension that corrosion will cause excessive cost of repairs, or unduly short life of the car.

As to the comparative cost of maintenance of steel and wooden cars, no accurate comparison is possible owing to the difference in construction and age, the comparatively short time the steel cars have been in service, and the modification of design of certain parts which have given trouble. The following table gives the average cost of repairs per freight car on certain roads, as taken from their reports for the year ending June 30, 1903, and it may be noted that the Erie Ry., Baltimore & Ohio Ry., Chicago & Alton Ry. and Chesapeake & Ohio Ry. use steel cars extensively, while the Chicago, Milwaukee & St. Paul Ry. has a number of cars with steel center sills. Steel cars are little used on the other railways in the list:

Railway.	Annual repairs per freight car.
Erie	$32.00
Baltimore & Ohio	35.00
Chicago, Milwaukee & St. Paul	35.90
St. Louis Southwestern	38.66
Chicago & Alton	43.40
St. Louis & San Francisco (1902)	53.53
Chesapeake & Ohio	61.42
Southern	72.04
Atchison, Topeka & Santa Fe	100.70

Careful itemized records of car repairs on wooden cars of an important railway showed an average of $19.40 per car. On the Bessemer & Lake Erie Ry., which has both wooden and steel cars carrying a very heavy coal and ore traffic, the maintenance expenses of the two types of cars are separated, and the results shown in the following tables are compiled from the annual report for the year ending Dec. 31, 1902:

	Steel Cars.	Wooden Cars.
No. of cars in service, 1901	4,033	2,119
No. of cars in service, 1902	5,287	2,089
Ave. repairs per car, 1901	$14.09	$38.16
Ave. repairs per car, 1902	14.93	49.61

On the Central Railroad of New Jersey, 1,000 steel hopper-bottom cars in service from April, 1901, to June, 1903, averaged $10.60 per car per year for repairs. On the Chicago Great Western Ry. the repairs to wooden cars averaged $21 per car per year ($11 for material and $10 for labor); the repairs for steel cars were estimated at $18.25. In repair work, material will represent about 65 to 70% of the expense on wooden cars, while with steel cars it will be only about 30 to 40%. The balance will be for labor.

On the Norfolk & Western Ry. the repairs to 50-ton steel-frame composite hopper cars, with wooden boxes, range from $20 for a car slightly damaged to $185 for a car badly wrecked. The work was done by ordinary repair gangs, and was classified as follows: 1, Cutting apart of entire frame, straightening, reriveting, and complete renewal of woodwork; 2, the same, but with only partial renewal of woodwork; 3, cutting apart, straightening, and reriveting half of the frame and renewing half of the woodwork; 4, straightening and repair without removal, and including repairs of slight damage. The first class includes also complete repainting and stenciling; while the others include only partial repainting and stenciling. In the average of all of these, labor represents 82% and material 18% of the total cost. The cars being of composite construction, it is reasonably assumed that wood was the principal part of the material charged. The distribution of average cost per car for these several classes of repairs is given in the following table:

Class of Repairs.	Labor		Material		Total.
1	$100.23	74 per cent.	$34.55	26 per cent.	$134.78
2	77.89	73 "	30.46	27 "	108.35
3	36.48	76 "	11.02	24 "	47.50
4	15.79	61 "	9.94	39 "	25.74

The experience with 16,000 steel cars on the Baltimore & Ohio Ry. has shown that neither the rusting nor the expense for repairs is as great as had been expected. It is also the general experience that the repairs (exclusive of wreck repairs) are generally due to rough handling and abuse rather than to ordinary service wear and tear.

One of the principal troubles is the corrosion of the steel, especially in coal cars, but even this appears to be less serious than had been anticipated. Under box cars and ordinary freight cars there should be very little trouble from corrosion. In coal cars the degree of corrosion, of course, depends partly upon the character of the coal and the amount of moisture in it. On the Norfolk & Western Ry. it was the practice to coat steel-frame cars with red lead, and these cars showed no serious deterioration after one or two years' service. As a result of the experience, it was decided that the small amount of steel exposed inside the car should be painted every six months, but that the ordinary rules as to repainting would be sufficient for the steel work on the outside. The use of good red-lead paint is also advocated by the Central R. R. of New Jersey, the surface being first thoroughly cleaned, and time being given for the paint to dry without the use of drying compounds in the paint, which will destroy the life of the oil. With an improvised plant, consisting of air compressor and sand blast, 1,000 steel hopper cars were cleaned and given two coats of paint at the rate of 10 cars per day and at a cost of less than $12 per car. On the other hand, the demand for cars is so great that they will have to give a very long service between paintings, and then be cleaned and painted in a hurry.

It has been suggested that wear and corrosion of the hoppers might be reduced by putting in a wooden lining, but it does not seem that this is necessary in a well-designed and well-built car. It has also been shown by experience with some composite cars, having steel frames and wooden sides, that the wood causes corrosion by holding moisture against the steel. If wood is to be used at all in the hopper, the better arrangement would be to have a steel frame carrying the planks, but actual experience with hopper cars does not indicate that any such arrangement is necessary.

In a report to the Master Car Builders' Association, in 1903, Mr. Humphrey, then Superintendent of Motive Power of the Chicago & Alton Ry., pointed out that corrosion occurs at the top corner of the side sills (pressed steel channels), where water drips through the flooring; and also between the steel stake and the side sill, owing to water which makes its way down between the side boards and the stakes. In composite box cars the side sheathing is sometimes nailed to a nailing strip laid on the top flange of the side sill. This brings the sheathing close against the sill, and the dripping water has in some cases caused serious corrosion. A better arrangement is where the nailing strip rests on a shelf angle riveted to the face of the sill, the sheathing extending below the angle; in this way the water drips clear of the sill.

It was thought in the earlier days of steel cars, that the organization and methods of repair work would have to be greatly changed from those employed with wooden cars, but this has not proved to be the case. On the contrary, it has been found that the ordinary repairs to steel cars can be made by the ordinary repair gangs employed on wooden cars, with the additional equipment of pneumatic riveters, chipping hammers (for cutting out rivets), straightening blocks and heating furnaces. Repairs to steel cars may be expected to take longer than repairs to wooden cars, and it is not unlikely that more of the work will be done in the shops or under cover than is commonly the case with wooden cars. Where new railway shops are built, therefore, provision is likely to be made for such work, and this has, in fact, been done in planning the new car shops of the Pittsburg & Lake Erie R. R. at McKeesport, Pa., which will be built this year.

A report on shop practice for the maintenance of steel cars, presented to the Central Railway Club last year, stated that this is not as serious a matter as had been anticipated if proper tools are provided. A simple equipment of pneumatic drills and hammers for drilling, reaming and riveting, and some kind of oil or gasoline forge for heating, is sufficient for all ordinary repairs. Bent sills, stakes, plates, etc., can often be heated and straightened without being taken down. Where the parts are badly damaged, however, they must be cut out and heated. It does not pay to ship damaged cars back to the builders to be repaired, and as a general thing, the railway blacksmith can readily make the repairs. Where large numbers of these cars are in use, it will generally pay to install punches, shears, hydraulic presses, etc., to prepare their parts from plates, bars and shapes bought in the market, and it will also be convenient to install an overhead crane to handle large plates, etc. One speaker remarked that the repairing of the steel cars is very little more difficult than that of wooden cars, when once the men have become accustomed to the character of the work, but the repairs will probably take a rather longer time. As to painting, paint sprayed on by an air jet will find its way into corners and crevices that cannot be reached with a brush.

In regard to the repair gang for steel cars, it is very generally understood that they should be recruited from the boiler makers, and, in fact, this is the practice on some roads. On the other hand, it has been said that the ordinary repair men are not merely carpenters, but are "general utility" men, and can readily learn how to cut out and drive rivets. On some roads, therefore, there has been little change in the repair gangs, except that the foremen are selected from men familiar with metal work, so that they can intelligently plan the methods of repair. Boiler makers may necessarily be employed when plates have to be laid out and shaped, or steel parts made. On the Baltimore & Ohio Ry. repair gangs of four men each are organized, one gang taking a car and doing all the repair work upon it. In this way a record can be kept of the labor required, and it is expected that piece-work prices can be more readily established than with wooden cars, the number of different operations being less. A few roads have already introduced the piece-work system in steel-car repairs.

As to wrecks, in three cases reported in our issue of May 28, 1899, steel cars were repaired for about $40 each ($28 to $30 for labor). In one of these accidents it is stated that had a wooden car been subjected to the same treatment there would have been nothing left of it but scrap. In collisions, and in derailments where cars have been thrown down high enbankments, it has been shown that the steel car will sustain little damage and may be easily put in running condition, while wooden cars will be to all intents and purposes completely wrecked.

As examples of individual experience in the matter of steel car repairs, we give the following summary of statements received from certain railways in reply to inquiries in this matter. The specific subjects of enquiry were as follows: 1, First cost and cost of maintenance; 2, Principal troubles with steel cars; 3, Damage in switching; 4, Repair gangs; 5, Improvements to facilitate repairs.

REPORTS ON THE MAINTENANCE AND REPAIR OF STEEL CARS.

CENTRAL R. R. OF NEW JERSEY.—1.—We have very little information regarding the cost of repairing steel and wooden cars. From observation, however, the steel cars compare most favorably with the others in this respect.

2. The steel cars we have in service have not developed any particular weakness. We have had pressed steel cars running for three years, and structural steel box cars, gondolas and hopper coal cars running for a few months. We find the pressed steel car twists up quite badly when wrecked or derailed, and would expect the structural steel car to do the same. These cars were built to run on rails, however, and we think we must base our calculations of their performance on these conditions.

3. Steel cars are not damaged to any extent by switching. In fact, they stand the switching treatment thus far much better than our wooden cars.

4. We repair our steel cars with gangs of selected laborers, usually designating the most intelligent man available for a foreman. As they become expert in this line of work, we advance their rate of pay to that of helpers.

5. We have in view the erection of a car repairing shed at our new shops at Elizabethport, N. J., and expect to include in this a department for repairing steel cars. This will include a crane and such other facilities as will be necessary for this class of work.

CHESAPEAKE & OHIO RY.—1.—In comparing the repairs of steel and wooden cars, the cost of maintenance of the former in ordinary repairs is very much less than that of the latter.

2. From our experience with steel cars, the principal item of expense will be to keep them painted.

3. We have considerable trouble from damage to steel

cars by reckless handling in switching and in wrecks. We have also had some trouble with drop doors, which become distorted through handling the cars when the doors are not closed properly.

4. We have special gangs for repairs of steel cars, but no heavy facilities for that work. Our main equipment consists of the ordinary air drills, riveters, etc., and a forge.

5. The motive power department is not considering any special steps towards reducing the repair work on steel cars, as it has no voice in the matter of discipline, and on the whole it has no fault to find with the construction of the cars. The trucks of the first 1,000 cars did not prove satisfactory, and these we are rebuilding.

LAKE SHORE & MICHIGAN SOUTHERN RY.—1.—The steel cars which we have in service are of the hopper type, 100,000 lbs. capacity. We have no wooden cars of this type in service, but should judge that if we were building such a car it would cost about $250 less than the steel car. As far as the cost of maintenance is concerned, the steel cars, up to this date, have not cost as much for repairs as wooden drop-bottom gondola cars in the same service. We have found, however, that the maintenance of steel cars has been higher than it should be, for the reason that the earlier cars which we procured were provided with very weak draft beams. As a result, we have had to overhaul practically all of them, reinforcing the draft beams to prevent them from buckling.

2. The principal item of maintenance with steel cars has been due to weak draft sills (as above noted), and to side and end plates becoming eaten with rust. The failure of draft sills or beams results in broken end sills, entailing considerable expense in repairs.

4. We are now repairing our steel cars by piece work, no special class of labor being required. The equipment consists of pneumatic riveters, chipping hammers, drills, pneumatic holders and dollies, screw-jacks, Pearson jacks, gasoline furnaces, and chains.

5. We are reducing the cost of maintenance by the use of the tools above mentioned, and also by the introduction of piece work. We feel, also, that there is still room for improvement in the design of some of the details of the steel cars.

NEW YORK CENTRAL & HUDSON RIVER RY.—1.—We have less than 300 all-steel cars. Very few of these have had to be repaired, with the exception of a few which have been in wrecks.

2. We are not aware that we have any more trouble in switching steel cars than in switching wooden cars. When steel cars undergo rough usage, they stand it about 30 or 40 % better than wooden cars.

3. We have special gangs for repairing steel cars and also for repairing Fox pressed steel trucks. We have about 58,000 pressed steel trucks. We have a shop fitted with overhead traveling cranes and all modern pneumatic machinery.

4. Since starting reparis to steel cars and trucks, we have been giving the matter serious attention, and find that we are improving all the time. We are considering the adoption of steel underframing in new equipment.

PENNSYLVANIA LINES WEST OF PITTSBURG.—1.—The cost of maintenance of steel cars has been very much less than that of wooden cars. The average of repairs to steel cars is greater per steel car repaired, the majority of repairs to steel cars being necessary on account of accident, and in numerous cases adjacent wooden cars are entirely destroyed.

2. The expense of maintenance of steel cars has been nominal, and we feel that with the exception of the cost of repainting (which is not very serious) this low expense will continue for some time. The repairs of these cars have been made necessary by accidents.

3. Some steel cars are damaged in switching by cornering. Few, if any, of these cars are damaged in unloading.

4. Practically all shops make repairs to steel cars damaged by minor accidents. Cars injured very badly are sent to one shop which is set apart for this class of work, and is equipped with some few appliances such as pneumatic riveters, a bed plate (made of rails) for straightening sheets, heating arrangements, a variety of wrenches with heads of different angles, etc. The equipment required is not very great, as it has been found that a number of parts can be straightened cold, without being cut from the car.

5. We have not taken any radical steps to reduce the maintenance of steel cars. Some minor changes have been made to facilitate repairs due to accidents, which are chiefly of the cornering type. The question of using every possible means to prevent cornering has been taken up.

PITTSBURG & LAKE ERIE RY.—1.—It is safe to say that the first cost of steel cars is not far from 25% more than for wooden cars of the same capacity. The cost of maintenance is much smaller.

2. Center sills and end sills have been found to make up the greatest cost in maintenance of steel cars.

3. We do not have so much trouble from damage to steel cars by reckless handling and switching as we do with wooden cars, from the fact that the steel car will stand much harder usage and show less distress.

4. We have a special gang for the repairs of steel cars. The equipment for this work consists of pneumatic hammers for riveting, and either gas or crude-oil furnaces, in which the members may be heated in order to be straightened. This is about all the special equipment beside that which is used also in the repairs of wooden cars.

5. During 1904 we shall build new car shops, and will install in them as many conveniences as possible for the repair of steel cars.

UNION PACIFIC RY.—1.—The first cost of steel cars is more than that of wooden cars. The cost of maintenance and repair is much less.

2. The principal item of expense in maintenance and repair of steel cars is in the end sills.

3. We have little trouble from damage in switching.

4. We have special gangs for repairing steel cars. The equipment consists of a large fire, bending rolls, portable furnaces, clamps, gasoline heaters, pneumatic hammers, etc.

X. Y. Z. RY.—(Name omitted by request).—1.—Steel cars originally cost about 33⅓% more than wooden cars. The last steel cars that have been built are quite an improvement over those first built. These cars are considerably cheaper to maintain; in fact, they require very few repairs, and then only those due to accident.

2. The principal items of expense are wheels, couplers and drop-doors. The painting will also be an item of expense which will follow later.

3. We have special gangs for repairing steel cars, which are not necessarily composed of a high class of labor. The equipment necessary for this work includes the pneumatic drills, hammers, riveters, etc., and portable oil furnaces. At three of our large shops, we have a large oil furnace of sufficient size to take in any size of sheet used in the construction of these cars.

4. We do not have much trouble on account of reckless handling of these cars. We do, however, find that considerable damage is done to the cars in unloading, especially in cold weather, when the ore or coal is frozen.

5. We are, at all times, considering ways and means of reducing cost of repairs to steel cars. Up-to-date tools and facilities add very much in reducing this expense. Well equipped shops, with overhead cranes, where cars can be easily handled, greatly reduce cost of repairs.

MAINTENANCE OF COMPOSITE CARS.

From Mr. W. H. Lewis, Superintendent of Motive Power of the Norfolk & Western Ry., we have replies to the above set of inquiries, but relating to composite cars instead of all steel cars. The information covers the results [illegible] a group of 50-ton cars with wooden bodies [illegible] metal underframes and to other 40 and 50-ton cars with metal under, side and end frames, and wooden bodies. All the metal work consists of rolled shapes, no pressed steel parts being used. With this explanation we give the replies as follows:

1. Cost of maintenance and repairs is [illegible] in favor of the steel cars; we cannot give the exact figures.

2. The principal troubles are with the couplers and draft gears on the bodies and the wheels on the trucks. The trouble with draft gears and couplers, however, has not been excessive on this road.

3. As to damage in switching we have a great many cars damaged at the ends, but it is our understanding that very little serious damage is done to the steel cars, short of collision or derailment accidents. The wooden cars, however, are severely punished by the steel cars in switching yards.

4. We have special gangs for the repairs of steel cars. At this time the only equipment in use is a heating forge and large surface table or anvil on which we straighten bent iron work; also pneumatic drills and hammers. We find a portable rivet forge useful in connection with small jobs of riveting at various places on the track set aside for this work.

5. A separate building is contemplated to house a complete outfit of tools and machinery necessary to repair or build new work from rolled shapes.

WORKS OF THE LOCOMOTIVE & MACHINE CO. OF MONTREAL, CANADA.*

By M. J. Butler, M. Can. Soc. C. E.

The Locomotive & Machine Co. of Montreal, Ltd., was incorporated under the provision of "The Dominion Companies Act," in 1902, with a capital of $1,000,000, subsequently increased to $3,000,000. The company purchased a piece of land (Fig. 1) lying between the Terminal Railway and the St. Lawrence River, in the parish of Longue Pointe, Quebec, Canada, comprising an area of 68.1 English acres, or 80.4 arpents and having a frontage on the St. Lawrence River of 1,102 ft. The main block of land (lying north of Notre Dame St.), is 860.6 ft. in width.

At the river bank the land lies at an elevation of some 18 ft. above the normal river level and rises with a gentle slope of ½ of 1% to the Terminal Railway in the rear of the property. The soil consists of a firm dry clay in depth from 20 to 30 ft. to the rock.

The property lies within the jurisdiction of the Montreal Harbor Trust, who are building a wharf and dredging out a ship basin, large enough to receive the largest type of ship, thus giving ample facilities for ocean and river transportation. At the rear of the property run the Terminal Ry. and the Chateauguay & Northern Ry., connecting with the Canadian Pacific Co., at Hochelaga, and via Jacques Cartier Junction with the Grand Trunk system. It is more than probable that in a short time all railways will meet on a common line on the harbor front, thus giving a more direct access to the works.

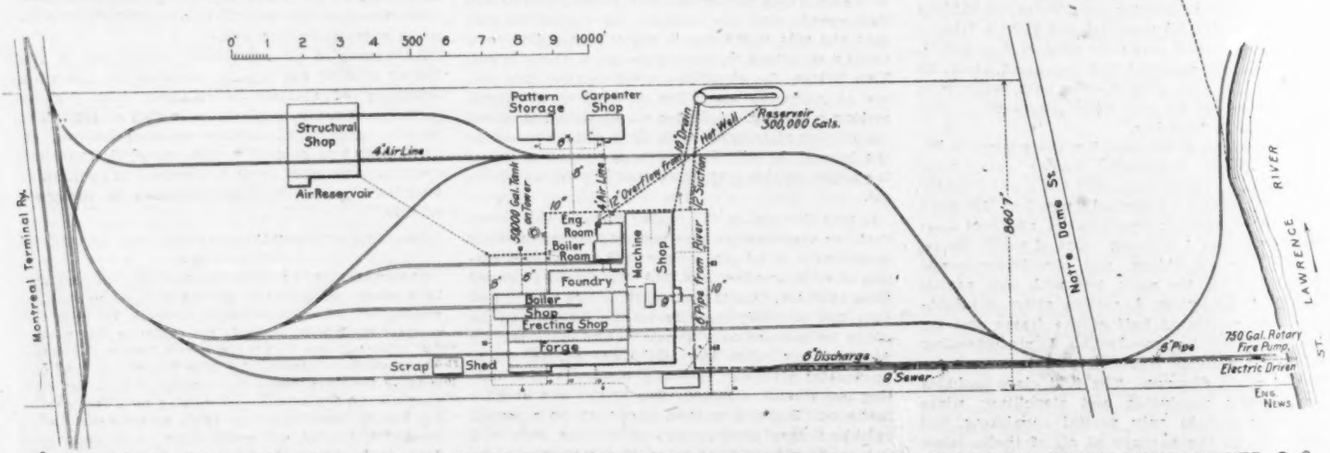


FIG. 1. GENERAL PLAN OF WORKS OF THE LOCOMOTIVE & MACHINE CO., OF MONTREAL, LTD., IN THE PARISH OF LONGUE POINTE, P. Q. M. J. Butler, Chief Engineer.

*A paper read before the Canadian Society of Civil Engineers.

The St. Lawrence River has been improved by dredging so as to give the largest ocean vessels direct access to Montreal. Extensive harbor work at the latter city is not yet completed.

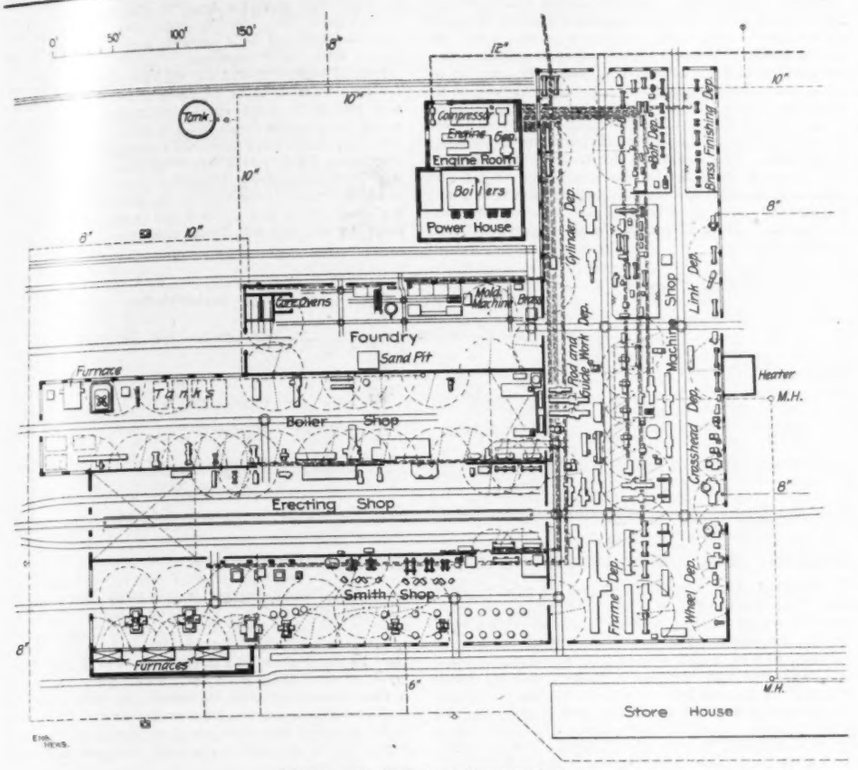


FIG. 2. LAYOUT OF MAIN SHOPS.

As shown in the plan of the property, Fig. 1, there is an extensive system of tracks in the company's property connecting the several buildings with the river front and the railway.

LAYOUT.—The general idea of the layout of the locomotive works proper is that of the President of the company, Mr. M. J. Haney, M. Can. Soc. C. E., and was only arrived at after long and careful study of the problems involved. The layout (see Fig. 2) is believed to be unique and without precedent in the various matters concerned, such as compactness and minimum distance of handling from raw material to finished product. The only objections raised against this style of shop have been: (1) a possible want of light, and, (2) increased insurance; both of which have been met. Indeed, it is believed that no similar shop has been insured at a lower rate; the light shows for itself in the interior photographs (Figs. 6 and 7).

The author was appointed Chief Engineer of the company on Dec. 5, 1902. The plans were started on the 19th of the same month, and on the 19th of January, 1903, complete bills of material were in the hands of the importers of the steel material. All pieces were specified to be cut to within ⅛-in. in length, it being the intention of the company to manufacture its own structural steel work, as inquiry had shown the impossibility of securing the work in time from the existing bridge and structural manufacturing companies. Pursuant to this end, during the month of February, the ground was broken for a temporary shop, built of wood, in which to install the tools required to do the work, and in the meantime orders were placed with the tool-makers for the several tools for delivery April 1. This shop (200 × 75 ft.) was completed early in March, but as the tools were not delivered until near the end of April, it was the 5th of May before the shop was under way, at work. On the 8th day of May the building was burned to the ground. By working night and day, a line of shafting was put up in the open field, the tools were repaired; new pulleys, belts, etc., were bought, and work started again on the 13th, the actual shut-down being five days. Work was kept going with a strong force of carpenters, and ultimately a shed roof was built over the working space 80 ft. wide × 300 ft. long, but for five weeks the only covering was the sky. I may say during the five weeks no rain fell.

In this temporary shop, the entire steel structural work, comprising some 2,000 tons, was manufactured and completed without further hitch, early in August. As fast as the material was manufactured it was erected and on the 15th day of August, 1903, when the photographs herewith exhibited were taken, the whole of the frames, roof trusses, etc., were erected in place. The erection of the steel work was handled with two traveling derricks. As a rule about one week was required to each shop.

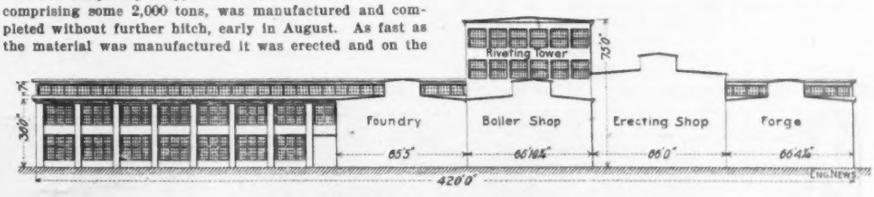


FIG. 3. REAR END ELEVATION OF MAIN SHOPS.

MAIN BUILDING.

The locomotive works proper consists of five shops, viz.:

1. A machine shop 132 ft. wide by 420 ft. long, and 36 ft. high, divided into two bays of 66 ft. each by a central line of columns, each bay being served by an overhead electric traveling crane of 10 tons capacity, traveling the entire length of the shop. A great number of fixed radial cranes serve each tool where required, thus obviating waiting for the traveling crane.

2. A forge and smith shop lying at right angles to the machine shop and on line with the west end of it, 340 ft. long by 66 ft. wide, and 36 ft. high. The several fires in the shop are served by fixed radial cranes. For traveling heavy pieces through the shop, cars are used on a center track.

3. Alongside of the smith shop is the erecting shop, 340 ft. long by 66 ft. wide, and 49 ft. high. This shop is served by two 60-ton electric traveling cranes. There is one surface track down the center of the shop, having a shallow pit running the whole length of the shop.

4. Alongside of the erecting shop is the boiler shop, 380 ft. long by 66 ft. wide, and 36 ft. high. At the south end of the boiler shop is the riveting tower, of the same width as the boiler shop and 40 ft. in length by 75 ft. high. In the tower are located the pump and accumulator, one hydraulic riveter with 17-ft. gap working under a pressure of 60, 80 or 125 tons, and one hydraulic riveter of 10-ft. gap working under the pressure of 60 or 80 tons. The pump works against a pressure of 1,500 lbs. per sq. in. The large riveter is served with a 20-ton hydraulic crane for boiler work, the small one with a 10-ton hydraulic crane for mud-ring and smaller work.

The boiler shop proper is served with a 20-ton electric traveling crane, which traverses the entire length of the shop. Aside from this, at each of the tools there is a fixed radial crane.

5. Alongside of the boiler shop is the foundry, 66 ft. wide, by 220 ft. long, and also 36 ft. high. The molding floor occupies 40 ft. in width for the entire length, while in the bay alongside is situated the cupola of 20 tons capacity. The core ovens, cleaning, chipping and molding floors are served by a 15-ton electric traveling crane, as well as a number of fixed radial cranes.

The brass foundry is up a half story in the side bay, and on the same level is the charging floor. The charging floor is to be served with a hydro-pneumatic elevator.

STRUCTURAL FEATURES.

The foregoing buildings are of structural steel framing with roof trusses of the same space throughout. The columns generally rest on cast-iron pedestals which in turn are supported on concrete base blocks; they are spaced 20 ft. c. to c. throughout.

WALLS.—The side walls for a distance of 4 ft. above the ground are of rubble limestone laid up in Portland cement mortar. At each column, extending from the stone work to the roof is a brick pilaster 4 ft. in width, laid up in Portland cement mortar. The space between the pilasters is largely glass, except for a band some six feet in width, which is made up of 2 × 4-in. pine studding (first dipped in Portland cement mortar), covered on both sides with expanded metal and plastered on the outside with Portland cement mortar and on the inside with the Imperial Plaster Company's plaster. The partition walls between the several shops are built of similar construction to the belt course.

ROOF.—The roof covering consists of 3-in. pine and spruce ship-lap plank spiked to nailing strips of 3 × 6-in. pine bolted to the steel purlins; this is covered with tar-and-gravel roofing. Every effort has been made to insure slow burning construction and to make the buildings as nearly fireproof as possible.

FLOORS.—The floor in the machine shop consists of 6 ins. of concrete resting on a layer of broken stone of an average thickness of 6 ins. Embedded in the concrete are 3 × 3 in. nailing strips to which the under floor of 3-in. pine plank is spiked, and the whole is intended to be overlaid with 1-in. hard birch flooring. In the forge and smith shop and the foundry the natural earth has been leveled off and tamped. In the boiler and erecting shops the floors are 3-in. plank resting on heavy sills, to be overlaid with 1-in. hard birch flooring.

LIGHTING AND FINISH.—The side lights comprise a large percentage of the outer wall area. On the roof of the machine shop, two monitors 16 ft. in width by 7 ft. high, with continuous side lights pivoted, run the full length of the shop. Similar monitors are on all the remaining shops. In the machine shop roof there are also three rows of skylights, in the foundry and smith shops one row, and in the erecting and boiler shops two rows each. All the glass in the sidelights is what is known as factory ribbed glass, while the skylights are glazed with plain wired glass. The skylight frames in the forge and foundry are of copper, in the other shops of galvanized iron. All the flashing is of crimped galvanized iron, the

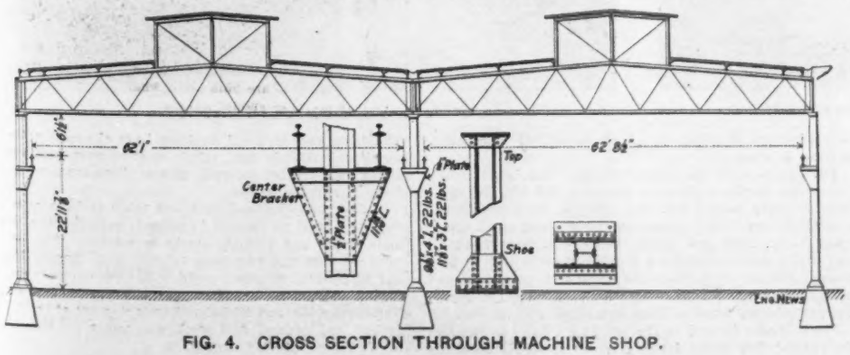


FIG. 4. CROSS SECTION THROUGH MACHINE SHOP.

cornice work is of plain galvanized iron and any siding used where walls do not occur is of corrugated galvanized iron.

Particular care and study was devoted to secure ample natural light, and the end aimed at has been attained. At night an abundance of arc and incandescent lamps give ample light.

MINOR BUILDINGS.

POWER HOUSE.—The power house has a rubble stone foundation and the rubble wall is carried up 4 ft. above the ground, the balance of the wall being of brick. The engine room is 50 ft. wide by 71 ft. long, the boiler room 50 ft. wide by 80 ft. long. A brick wall separates the two rooms. The roof is supported by steel trusses. Those in the engine room were designed for a concentrated load of 10 tons at any point in addition to the regular roof load. Those in the boiler room were designed to support two 20-ton coal hoppers in addition to the regular roof load. The roof covering is of 3-in. pine ship-lap plank, covered with tar-and-gravel roofing.

In the boiler room the floor is of concrete, in the engine room of 3-in. plank supported on heavy beams and overlaid with 1-in. hard maple flooring.

PATTERN AND CARPENTER SHOPS.—These two shops are together in a brick two-story building 66 ft. by 112 ft. The foundations are of rubble limestone laid up in Portland cement mortar up to 5 ft. above the ground level, and the remainder of the walls is brick. The columns of 12 × 12-in. pine are spaced 12 ft. on centers one way by 22 ft. the other and rest in a cast-iron shoe plate bedded in a concrete base capped with the usual cast-iron pintle. The running beams consist of four pieces of 9 × 9-in. tamarack ship-fastened together making a girder 18 × 18 ins. The floors are of 2 × 4-in. pine nailed together and to the beams and covered with 1-in. hard maple and birch, making a floor 5 ins. thick. The roof columns are of 10 × 10-in. pine, the foot resting directly on the cast-iron pintle. The roof girders or beams are of 8 × 12-in. pine, the roof sheeting of 3-in. ship-lap plank covered with tar-and-gravel. Large windows in all four sides of the building glazed with factory ribbed glass give ample light. The interior is whitewashed. There is an elevator of the hydro-pneumatic type, 10 × 13 ft. All the walls are carried above the roof about 12 ins. and gutters lead into down spouts inside of the building.

PATTERN STORAGE.—This building is 66 × 98 ft., one-story in height. It consists of brick walls, wooden columns, beams, roof-sheeting, etc., designed on the same slow burning lines as the pattern and carpenter shops.

STOREHOUSE.—The storehouse, 100 ft. long by 36 ft. wide is a brick two-story building with a basement and has also been designed as a slow-burning building, the beams, columns, floor and roof being similar to those of the pattern shop. At the present time the upper floor is used for general office, drafting rooms, etc.

STRUCTURAL SHOP.—As now finished, this building is 200 ft. wide by 200 ft. long, although planned to be 300 ft. in length. The height in the clear under the roof trusses is 22 ft. The roof trusses are spaced 20 ft. c. to c. and are figured for a concentrated load of 10 tons; on the outer walls they are supported upon steel columns, at the center by a 100-ft. span truss, leaving one column in the center of the building; the lower chord of the cross trusses is continuous so that a trolley can travel the entire width of the shop. The monitor is 40 ft. in width and 10 ft. high, running the length of the shop; both sides are of glass, and skylights are provided in alternate panels over the roof. A large percentage of the end and side walls is of glass. All the glazing in the side lights consists of factory ribbed glass, while the skylights are of plain wired glass. Two material tracks of standard gage are on opposite sides of the building, and an assembling track runs through the center. The side walls are of brick, the end walls of 3-in. plank covered with corrugated galvanized iron. The roof sheeting is of 3-in. ship-lap plank covered with tar-and-gravel roofing; the hip is covered with crimped galvanized iron. The floor is of 3-in. plank on heavy joists. Notwithstanding the width of this building, it is well lighted with natural light. The great advantage of the factory ribbed glass is the diffusion secured and the absence of concentrated beams with the attendant shadows.

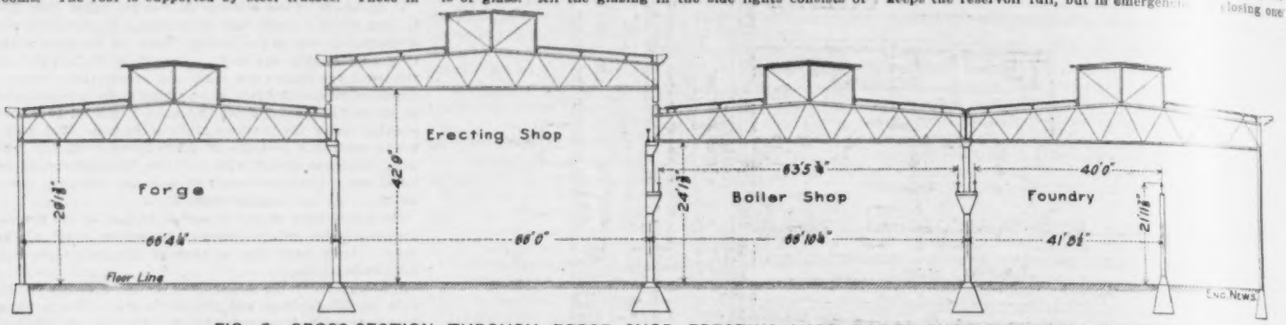


FIG. 5. CROSS-SECTION THROUGH FORGE SHOP, ERECTING SHOP, BOILER SHOP AND FOUNDRY.

MISCELLANEOUS EQUIPMENT.

There is a 9-in. sewer from the works to the river. All the roof drainage is conducted to a reservoir. All down pipes are inside and all gutters are back from the cornice.

The boiler equipment consists of four Babcock & Wilcox water-tube boilers, fitted with superheaters, of 250 HP. each, arranged in two batteries. The boilers are equipped with Jones automatic underfed stokers. The draft is well taken care of by a Sturtevant induced-draft plant. Overhead are two coal hoppers, each of 20 tons capacity, from which pipes will lead to the automatic stokers. The coal will be hauled up on a trestle to the top of the building in small cars, dumped into a Jeffrey coal breaker from which it drops into the bins.

The machinery in the entire works is motor-driven, with direct-current distribution. Both individual and group-driving is used.

The engine-room equipment includes: One Laurie cross-compound Corliss condensing engine of 500 HP. belted by a 39-in. 3-ply leather belt to a 400-KW. Western Electric generator; one 75-HP. Ampere motor working off the Montreal Light, Heat and Power Co. circuit from Shawinigan Falls, coupled direct to a 60-KW. Western Electric generator; and one cross-compound steam and cross-compound air Canadian-Rand-Drill compressor of 2,000 cu. ft. capacity per minute, fitted with an independent condenser.

There is also located in the building a 1,000-gallon Underwriters' Fire Pump drawing its water supply from the reservoir and pumping into the fire-[illegible] mains, tanks, etc. All the steam plant [illegible] has been designed for a working pressure [illegible] sq. in. with 100°F. superheat.

FIRE-PROTECTION AND WATER SUPPLY.—The water supply for drinking purposes is taken from a drilled well 500 ft. in depth and is distributed throughout the works by a steam-driven deep well pump. All the roof drainage, the overflow from the condenser-well, etc., drains into a reservoir of 300,000 gallons capacity. On the river bank is located a 750-gallon rotary pump driven by an electric motor, connected to the distributing mains and the reservoir by a 6-in. cast-iron pipe. Ordinarily it keeps the reservoir full, but in emergencies, by closing one valve and opening another it can pump direct into the fire-protection service. The 1,000-gallon Underwriters' pump in the power-house takes its supply from the reservoir through a 12-in. cast-iron suction line and distributes the water about the works. There is also a 50,000-gallon tank elevated on a steel tower 100 ft. in height, directly connecting with the mains and upon which the sprinkler system depends for a steady supply and head. It should be noted that all of the shops except the structural shop and the storehouse are fully equipped with automatic sprinklers.

HEATING.—The locomotive shops are heated by the Sturtevant hot-blast system, using exhaust steam supplemented with live steam. There are two fans driven by direct connected engine. The hot-air is conducted in conduits, and is so distributed as to reach the outer walls, risers being supplied in each bent, then discharging close to the floor and along the windows.

GENERAL NOTES.

The pressure allowed on the clay under columns was not allowed to exceed 3 tons per sq. ft. The concrete pedestals were not allowed to be loaded beyond 15 tons per sq. ft. Cast-iron pedestals were used to distribute the load on the concrete. All roof-trusses were designed to carry a load of 50 lbs. per sq. ft., and in addition the various concentrated and special loads which have been noted.

All the material used was medium steel, in accordance with the requirements of the Manufacturers' specifications. The tests and practical working have shown a uniform, tough and reliable steel. Unit stresses were kept within 16,000 lbs. per sq. in. making due allowance for column formula and for impact.

In designing the work care was taken to have as many duplicate parts as possible in order to save detailing, template work, and possible errors in erection. The entire work of detailing was done by two men, Messrs. Legat and Stennsken, to whom credit is due for the uniform accuracy of their work. The shop work was handled satisfactorily by Mr. Jud Nichols. The laying out of the foundations and general field work was under the charge of W. V. Taylor, M. Can. Soc. C. E.

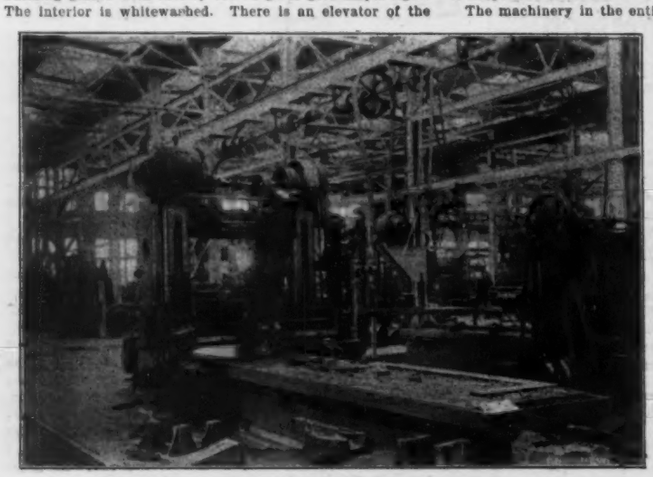


FIG. 6. VIEW IN MACHINE SHOP, EASTERLY END.

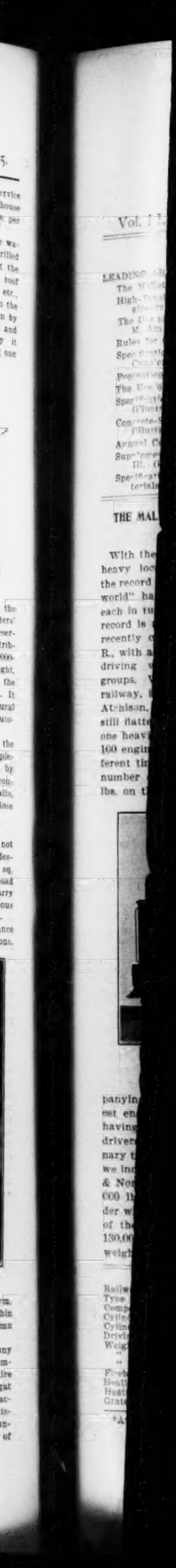



FIG. 7. VIEW IN MACHINE SHOP.